MACHINE DESIGN

Fig. 1—One hydraulic cylinder operates scraper through digging (left), carrying (not shown) and dumping (below) positions

Hydraulics and Welding Dominate Road Show

By G. W. Birdsall

RECENT years have seen several distinct trends in the design of road building machinery as illustrated by equipment at the 1938 Road Show. These trends include increased use of welded steel, low pressure pneumatic tires, "streamlined" enclosed cabs, power-operated controls and diesel engine power.

In seeking to reduce weight without lessening strength or rigidity many manufacturers have gone to low alloy, high strength steels such as Cor-Ten, Sil-Ten, Cromansil and others. These, with construction particularly designed for welded fabrication, permit the use of high unit stresses in relatively small sections.

As more and more persons have come to associate modern "streamline" design with modern performance, this factor also has received much attention. Here welded construction, in conjunction with adequate forming equipment, makes possible smoothly rounded contours without visible joints. Elimination of bolt and rivet heads is possible, also. One author-

Fig. 2—Left—Scraper utilizes flexible steel-encased cables to control the valves from operator's position. Fig. 3—Center—Handwheels and worm-actuated levers control mixing blades

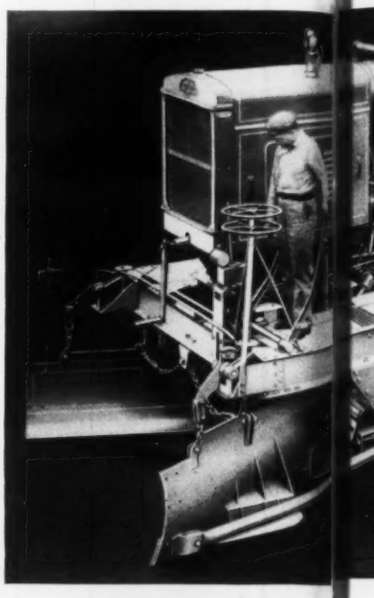
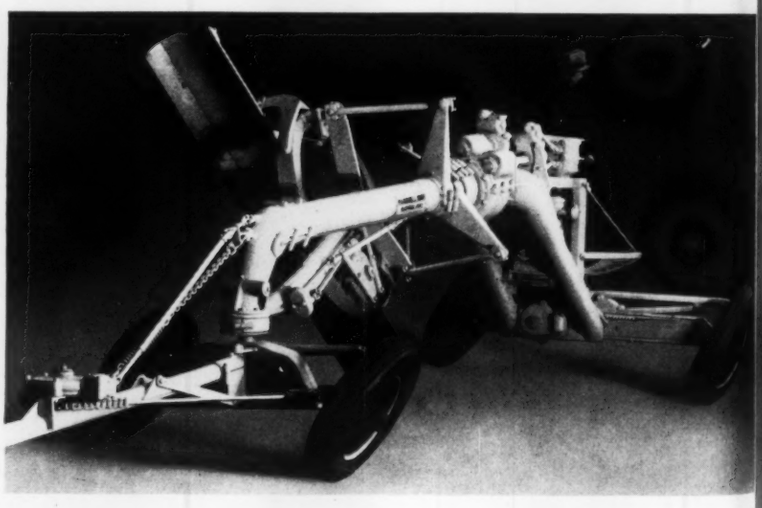


Fig. 4—Below—Tubular frame for grader provides strength and rigidity in all directions. Power-operated controls facilitate efficient operation of grader and relieve operator fatigue



ity estimates over half of all new road building equipment utilizes welded steel. This represents an increase of about 50 per cent over a year ago. A box section forming a boom of a recent shovel employs a particularly interesting application of welding where outside plates are fastened to underlying plates by plug welds.

For handling heavy loads over soft or muddy earth, low pressure rubber tires with treads up to 20 inches in width are being used. Their greater supporting area contributes much to ease of handling. Fully three-fourths of new road building equipment is on rubber, it is estimated.

Diesel engines continue to gain in popularity as a very large proportion of new road building equipment is so powered. Hardsurfacing at points where high rates of abrasion and wear occur is finding a greatly expanding field of application due to development of new materials and procedures for this work.

Yellow Color Widely Accepted

Finishes incline toward use of a standard shade of yellow, long employed on Caterpillar equipment and now specified by a large proportion of county engineering departments. A bright yellow tinged with orange, this color is used primarily for its high visibility.

Although few central lubricating systems are used, a large number of machines include pressure grease fittings to aid lubrication. Some models employ tubes from hard-to-reach bearings to easily accessible points where fittings are mounted.

Improved loading characteristics are obtained in "Carrimor" scrapers built by LaPlant Choate Mfg. Co., Cedar Rapids, Ia., by using a bell-shaped bowl instead of a straight-sided bowl. The 16-yard model, *Fig.* 2, employs a number of hydraulic cylinders to operate pan, rear push gate and front apron. Multiplicity of hydraulic lines to the control station on the tractor unit is eliminated by mounting control valves on the scraper and connecting them to the operator's control levers by flexible steel-encased cables. Breakage is prevented by automatic by-passing of hydraulic power in emergency.

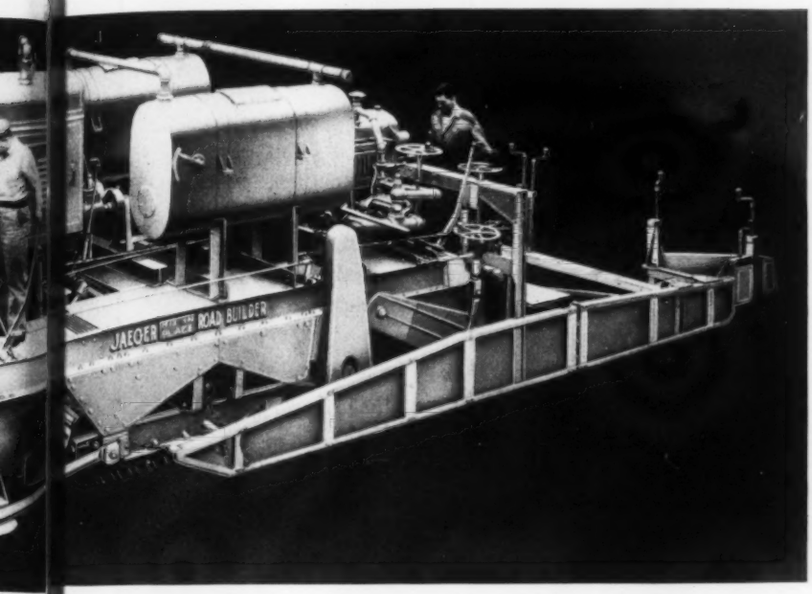
On small models of these units, it is highly desirable to free the operator from a large number of controls. The model in *Fig.* 1 is almost automatic as operation of one cylinder controls the various scraper functions through a series of levers and toggles. To permit this scraper unit to be used with bulldozers,

snow plows and other tractor units, this scraper is designed to utilize the hydraulic pump and controls already part of the tractor unit, thus saving the cost of these accessories.

The "Ranger" grader shown in Fig. 4, made by W. A. Riddell Corp., Bucyrus, O., is a good example of equipment built around a tubular frame. Called upon to do heavy work in a wide variety of positions, the heavy seamless tubular frame affords positive bracing in all directions.

Much road equipment utilizes power controls operated directly from the engine through gears and clutch mechanisms. Connected to various elements through rods and universal joints, these provide quick, efficient control. The mix-in-place Jaeger road builder, *Fig.* 3, however, is an exception in that handwheels and worm-actuated levers control the position of mixing blades. This machine also uses renewable tips on gathering screws and cutting edges of gathering blades. Large tachometers show rate of forward travel and speed of the metering pump feeding bitumen into the mix.

Heavy slow-moving machinery affords no little transportation problem. Several manufacturers have provided auxiliary wheels and transmissions for rapidly moving equipment from place to place under its own power.



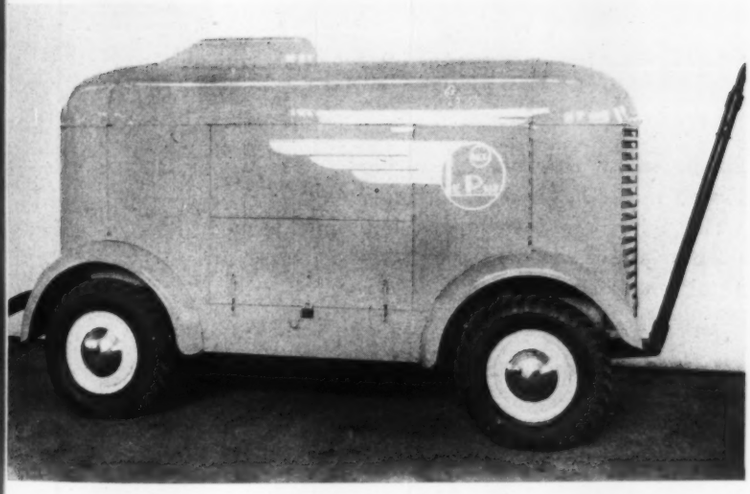


Fig. 5—Above—Automotive styling features this portable air compressor

Mixes Two Batches Simultaneously

Koehring Co., Milwaukee, obtains increased capacity for its large Model 34-E paver by providing an extra large mixing chamber which simultaneously mixes two batches separated by an inside ring. Flexibility is provided in this ring by making the inner portion of rubber. Euclid Road Machinery Co., Cleveland, on its 15-yard bottom dump Trac-Truk, *Fig.* 6, employs a door-closing device with a cable drum actuated by a wheel in contact with the left tire during the closing operation.

A toggle mechanism has been developed by the Hercules Steel Products Co., Galion, O., in its "Center-Lift" hoist for dump trucks. Combined with a short rack and pinion section, it produces an almost vertical lift with high power to start the load and increasing speed as the body is raised.

The sales stimulus afforded by modern "streamlined" design is illustrated by Le Roi Co., Milwaukee, in its "Airmaster", 160-cubic-foot, two-stage, portable air compressor in *Fig.* 5. Following automotive styling, it uses low pressure rubber tires, highly-finished radiator grill in front and smoothly rounded corners throughout. Deeply formed fenders and a top "streamlined" vane add to the effect.

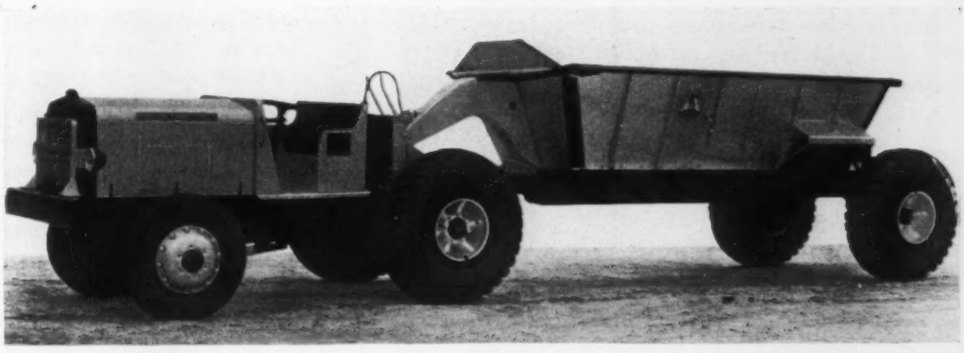


Fig. 6—Right—Unique door-closing device on this bottom dump truck is operated by friction wheel contacting rear tire

Scanning THE FIELD FOR Ideas

A METHOD of inspecting machine parts for hidden flaws without changing or injuring the parts in any way has been developed by the General Electric Co. This system depends on the principle that any change in the constitution or state of magnetizable material is reflected by its magnetic characteristics.

As explained by J. A. Sams of the laboratory staff at Schenectady, the mechanism—of which important details are shown in *Fig.* 1—produces a constant magnetic field which penetrates the entire thickness of a small area of the part to be inspected.

The part, which in the illustration happens to be a forged steel turbine bucket wheel, is revolved slowly between the poles of the coils which set up the magnetic field. These pole pieces at the same time feed across the work until it has been completely explored magnetically. The machine as a whole somewhat resembles a vertical boring machine, in that the work is rotated by a central vertical spindle while the magnetic heads travel laterally on rails under the influence of a feed screw.

Imperfections such as voids or nonhomogeneous areas in the exterior of the part betray themselves by producing disturbances in the magnetic field at the surface. Being mounted close to the surface, the magnetic search coils instantly detect any sudden change in the "magnetic linkage" created by discontinuity in the metal revolving between them. This produces a sudden and corresponding electric voltage change in an external measuring circuit which is hooked up with suitable instruments.

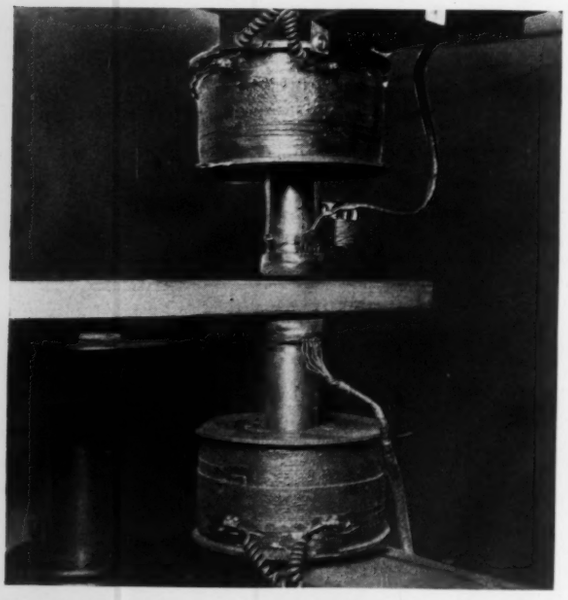


Fig. 1—Variations in current caused by disturbed "magnetic linkage" detect hidden flaws in steel

Through these instruments any imperfection, its location and a clear idea of its seriousness are instantly made obvious to the observer.

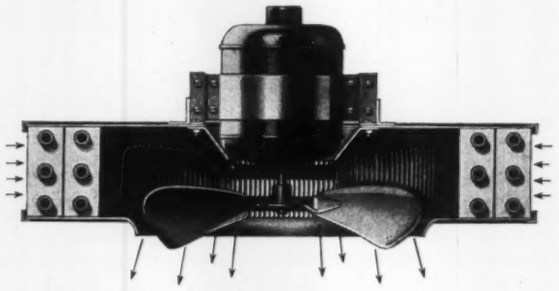


Fig. 2—Unit heater is designed to project a cone of warm air to the working zone near the floor

Projector Warms Working Zone

FOLLOWING principles comparable to the diffusion of light from direct reflecting lighting fixtures on the ceiling, a space heater of projection type has been developed by the Trane Co. One of these units, sectioned to reveal its mechanism and internal design appears as *Fig.* 2 at the top of this column.

These units, which are ceiling mounted, consist of multiple turn steam coils with radial fins which are held between metal disks with open centers. On the top of the upper or supporting disk is a resiliently-mounted vertical motor. Below this and directly connected to its shaft is a four blade propeller fan. This revolves in the opening of the lower disk, drawing in air laterally through the fins and around the coils where it is heated and discharging this heated air

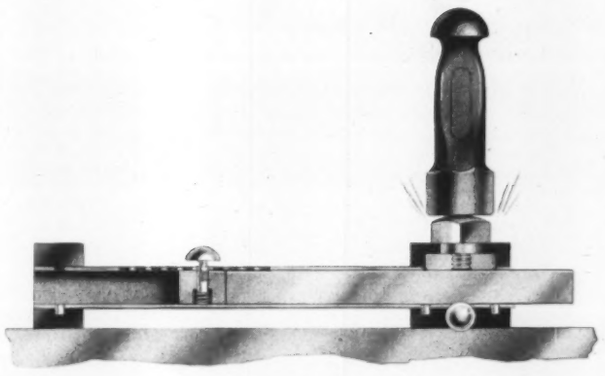


Fig. 3—Following the hammer blow, hardness is determined from relative indentations in bar and work

downward in a broadening cone.

As this air stream enlarges, flood-light fashion, its velocity decreases so that by the time it reaches the floor there is no noticeable draft. This stream in its downward course also induces a large volume of adjoining air to flow along with it, which results in a gradual temperature drop. After reaching the floor where the air cones from adjoining units merge, the direction of air flow becomes horizontal.

Thus the effect not only is to heat the air but also to prevent the natural stratification of heated air near the ceiling by constantly "pumping" it down to the lower levels where it really is useful.

Tests Hardness "On The Spot"

DEVELOPED originally for field testing of welded rail ends, an instrument called the Telebrineller, illustrated by *Fig.* 3, above, not only is unique in design and operation but also holds possibilities for the testing in place of machine parts which would be difficult or impossible to get at with the laboratory-type of hardness testing equipment.

This portable instrument, which is made by Teleweld, Inc., weighs—complete with case—only 6½ pounds and can be used successfully by a relatively inexperienced operator even outdoors under adverse weather conditions.

The apparatus has as its principal part a square metal tube supported by a soft rubber head (right) and a rubber spacing block (left). The tube holds a square, ground bar of known hardness. An anvil in the top of the rubber head rests directly on this bar, while embedded in a hole in the rubber below the bar is a replaceable hardened "impression ball" which is in direct contact both with the bar (above) and the work to be tested (below).

To make a test the instrument is held against the part to be tested and the anvil is struck a single sharp blow with a 3 to 5 pound hammer. The impact is transmitted through the anvil to the bar, then to the ball and on to the work. Force of the blow is not a factor, the diameter of the resulting impressions of the ball in bar and work always being relative to their respective brinell hardness numbers.

Next the bar is removed from the tube and a portable microscope which comes with the instrument is used to measure to twentieths of a millimeter; first, the diameter of the impression in the bar; and second, the diameter of the impression in the work. By dividing this first diameter by the second, multiplying the result by itself and then multiplying that product by the brinnel hardness number (BHN) which is stamped on each bar, the BHN of the work is found. This is a quick and simple computation on the slide rule which is included in the outfit.

The bar is fed along in its tube by a spacing block having a spring catch button which locks in ten positions in the tube. By turning to utilize the full length of all four faces, each bar gives 80 impressions.

Packing Is Kept Away From Shaft

SIDE entering propeller-type mixers, particularly those used on applications where corrosion and chemical attack are involved, present difficult problems of stuffing box and bearing design. *Fig.* 4, below, illustrates a unique method of solving these problems, on which system a patent has been applied for by the Mixing Equipment Co.

Of primary interest in this new design is the fact that the stuffing box itself actually has no contact with the shaft proper. A "folded back member", consisting of a hollow cylinder open at one end securely attached to and revolving with the shaft, takes all wear at the packing area. At the same time this arrangement effectively prevents contamination of the "mix" by stuffing box lubricants and is effective in keeping the tank contents entirely away from the bearings, which it will be noted occupy the same linear dimension as the stuffing box.

It will also be noted from the illustration that the bearings, which are mechanically separated from the stuffing box, are so placed as to prevent whip of the

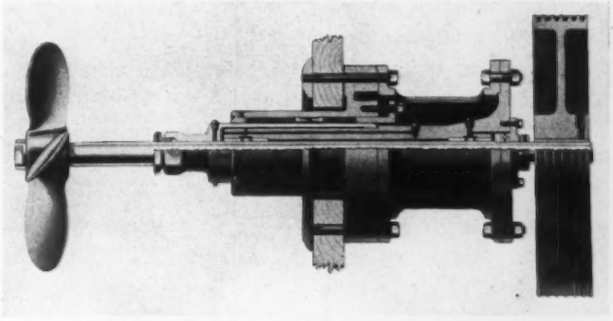


Fig. 4—"Folded back" member relieves shaft of stuffing box wear and gives bearing protection

shaft. The stuffing box is designed so that it can be lubricated from, and repacked from, outside the tank. The stuffing box sleeve is removable for replacement in the event of wear after long service.

While this new design will fit all types of applications, it is intended primarily for those difficult and hazardous locations where its extra cost is justified. Such cases are for instance: On tanks never emptied except in emergencies; where the product is explosive or otherwise dangerous; and where it is impossible or unsafe for a man to enter the tank for the purpose of repacking the unit.

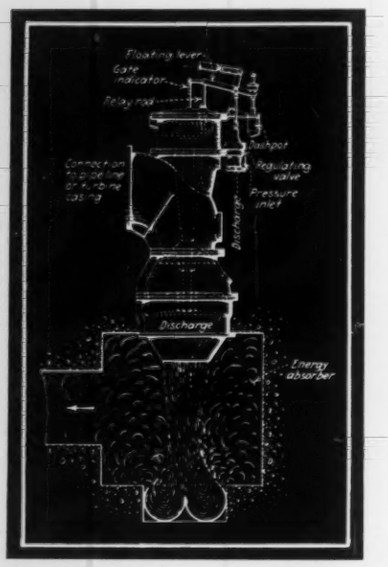


Fig. 5—When this high head water turbine pressure regulator causes a direct discharge into the tailrace, what would otherwise be highly destructive kinetic energy is absorbed harmlessly by splitting the stream and reversing it against itself

In addition to its application to these mixers, which range up to 20 horsepower, applications of this same principle—under license—also are under consideration for pumps, turbines, propeller shafts of boats, etc.

Energy Absorber "Cancels" Power

WHEN dealing with high pressure water traveling at high velocities in connection with hydraulic power installations, it scarcely can be thought of as a "liquid" in the familiar sense but rather as a "solid" material embodying tremendous destructive power if not handled properly.

In designing pressure regulators for high head water turbines there must be taken into account the great amount of energy which is discharged to the tailrace when the relief valves of the regulators open. When the head is high the kinetic energy contained in this direct discharge represents approximately the energy which otherwise would be produced by the turbine. Therefore it is necessary somehow to dissipate the major portion of this energy to avoid destructive effect in the tailrace.

How this has been accomplished by the Allis-Chalmers Mfg. Co. in the case of a 2500-foot head installation is shown diagrammatically by *Fig.* 5, left. By thus directing the stream into a strongly built "double-bucket" chamber, it is split and "turned back upon itself". As a result, energy equivalent to the 20,000 horsepower output of the impulse wheel to which the regulator unit is connected is safely and harmlessly absorbed by the water itself in a relatively small space and without mechanical complications.

Welded Drums Are Used For Drying

DEVELOPED for use in the paper, soap, pharmaceutical, textile, chemical and other process industries, the heated drying drum depicted in partial section by *Fig.* 6, is an excellent example of a large machine part which all the way through has been designed for fabrication by welding. This drum, which is a recent development by Lukenweld, Inc., can be manufactured in various sizes up to 15 feet in diameter and in face widths limited only by transportation restrictions.

The drum which is illustrated is of double-shell construction. The steam or other heating medium enters through the journal at one end, passes through channels which are integral with the built-up welded spokes, and thence into compartments between the inner and outer shells, condensate being automatically and continuously drained off.

Although of relatively light weight, these welded steel drums—because of the strength and uniformity of their material—are capable of operating with complete safety under pressures up to 150 pounds per square inch. Incidentally, the outer shell is made of a special close-grained steel of good machining properties, which is capable of taking a high polish to give a fine drying surface. A chromium plated shell is applied when non-corrosive mirror finish is needed.

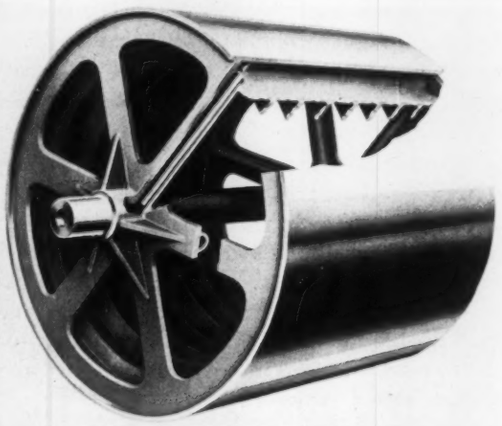
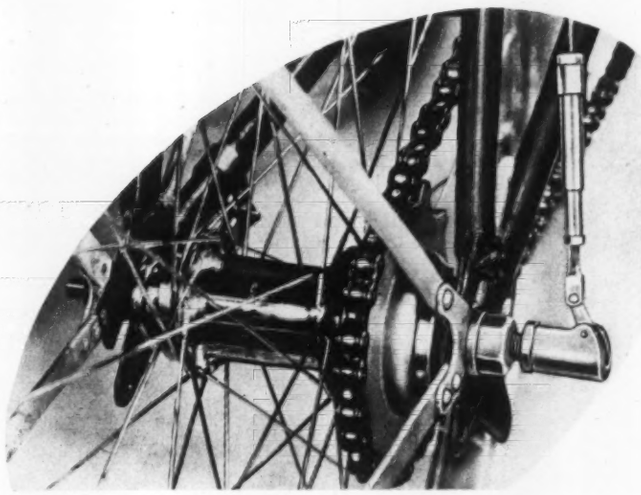
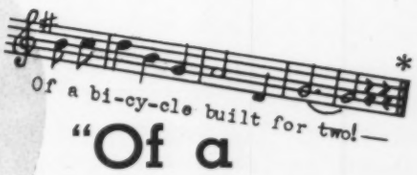


Fig. 6—Drying drums of welded steel resist internal pressure without being unduly heavy





"Of a Bicycle Built For Two"—Speeds

Fig. 1—Two-speed coaster brake in action, with cable control set for low gear

BICYCLES of fixed gear ratio ordinarily represent a compromise between power and speed. As a result their hill climbing ability is limited, while at the same time they are not capable of the most efficient performance on smooth level roads.

To improve their capabilities in both directions, engineers of the New Departure Division, General Motors Corp., have developed the two-speed coaster brake shown in *Figs.* 1 and 2. Through a simple and compact planetary gear system, a hill-climbing ratio 20 per cent below that of the ordinary bicycle is made available, along with an over-speed ratio 17 per cent above the normal. As shown diagrammatically by *Fig.* 2, the brake elements essentially are of standard type, the two-speed mechanism being confined mainly to an extension of the driver.

When the central sliding gear is moved to the left, it locks three planet pinions to the driver-sprocket, pinions and driver then rotating as a unit. This is the low ratio or hill-climbing position, for which the brake in *Fig.* 1 is set. When this same sliding gear is moved to the right—as in *Fig.* 2—it locks to a cone ball race immovably fixed to the axle. In this position the planet pinions travel around the center gear and the driver—which has an internal gear—is driven at a speed faster than the sprocket. This gives the "over-drive" so desirable on smooth, level roads.

Shifting of the center gear is effected by two keys moving in a slot, these being held together by a shifting rod within the axle extension. When shifting into low gear this rod is pushed inward against the pressure of its return spring by the cable-operated bell crank at the right. This cable is guided along the frame by one or more pulleys, to a self-locking hand lever just behind the handle bars.

To translate into dependable commercial form what able designers have accomplished by condensing this practical two-speed mechanism into a space only slightly larger than occupied by a single-speed brake, all principal parts are made of nickel steel, nickel-chromium or manganese steels—treated for maximum toughness and strength.

* *Courtesy of Harms, Inc., N.Y.C.*

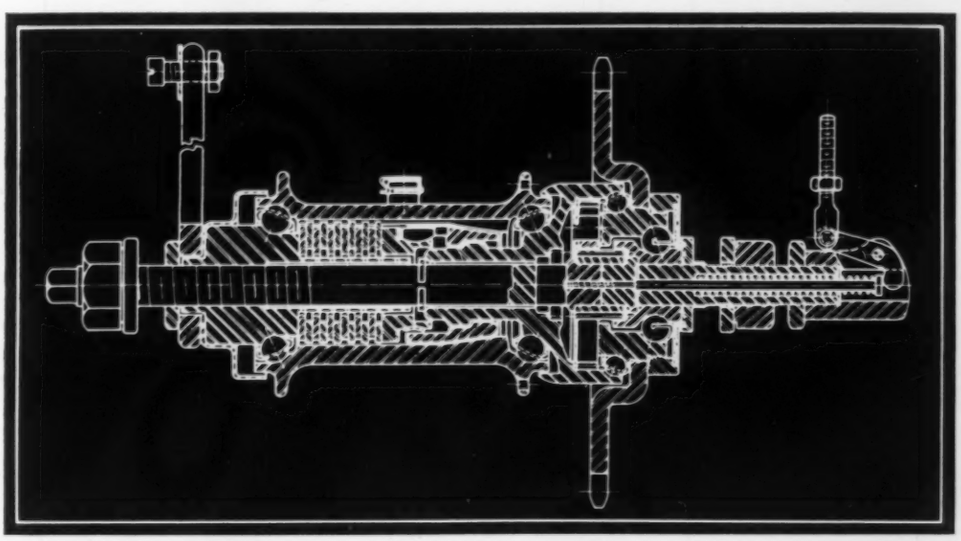


Fig. 2—Cross section of two-speed brake at its axis, revealing compact arrangement of planetary gears and their control at driving (right) end. High gear setting is shown in this drawing

General Considerations in Designing

Working Stresses in Helical Compression Springs

By A. M. Wahl*

IMPORTANCE of helical round wire compression springs demands that the present article be devoted entirely to their design. In particular the method for selecting working stresses, as discussed in the first article of this series, will be developed in detail to facilitate practical application. Particular reference will be paid to the effect of spring index (ratio of coil diameter to wire diameter) on the choice of working stresses.

*Mechanics division, research laboratories, Westinghouse Electric & Mfg. Co.

The ordinary formula for calculating stress in helical compression or tension springs is derived by assuming that the spring forms a straight bar subjected to twisting moment Pr where P is the load and r the mean coil radius. This is approximately true for a spring of large index axially loaded, as shown in *Fig.* 1. On this basis it may be shown from fundamental formulas that:[1]

$$\text{Maximum shearing stress } s = \frac{16\,Pr}{\pi d^3} \quad \ldots\ldots\ldots\ldots (1)$$

$$\text{Total deflection } \delta = \frac{64\,Pr^3 n}{Gd^4} \quad \ldots\ldots\ldots\ldots\ldots (2)$$

Tests carried out[2] by measuring the deflection of the coils in helical springs of large and of small index (ratio of mean coil diameter to wire diameter) have shown that equation (2) is very close to the truth for calculating spring deflections. On the other hand, equation (1), while fairly accurate for calculating stress in springs of large index (*Fig.* 1), may be shown to be considerably in error[3] when used for a spring like that in *Fig.* 2, which has an index of three. This value of spring index is about as small

1. All stresses considered in Part II are shear stresses.
2. "Further Research on Helical Springs of Round and Square Wire", by A. M. Wahl, *Transactions* A.S.M.E., 1930.

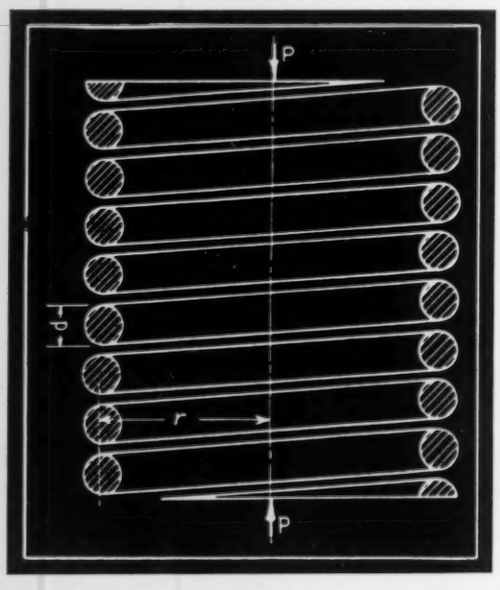


Fig. 1 (Above)—Round wire helical spring of large index, axially loaded

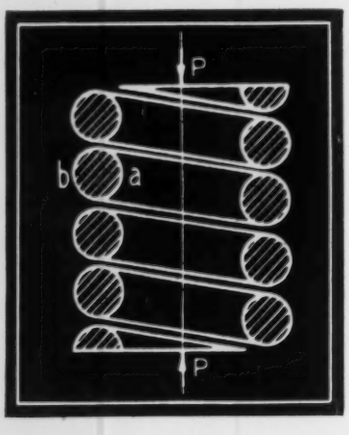


Fig. 2 (Left) — Helical spring of small index, axially loaded. Index, or ratio of mean coil diameter to wire diameter, of this spring is about minimum employed for normal conditions

Fig. 3 (Right)—Method of measuring stresses in actual springs

Mechanical Springs

Part II

as any used in practice. The reason for this stress increase is that when considering the spring as a straight bar under torsion, stresses due to the direct shear produced by the axial load and stress concentration effects produced by the curvature of the wire are neglected. (The stress augment due to curvature follows as a consequence of the difference in fiber length between the inside and outside of the coil). The result is that the stress at *a* (*Fig.* 2) on the inside of the coil may be two or more times that of *b* on the outside. To take these effects into account, the ordinary formula for stress as given by equation

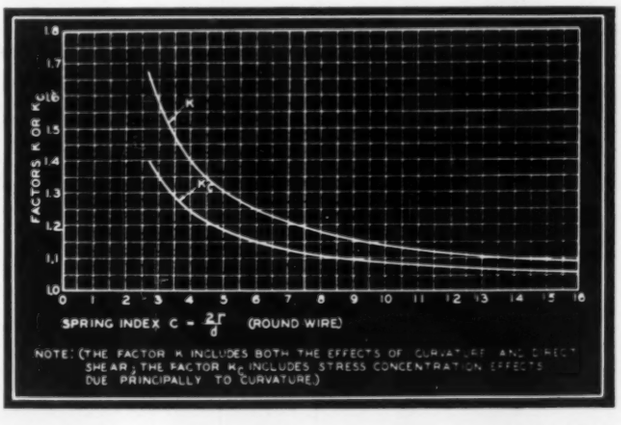

FACTORS K OR Kc
K
Kc
SPRING INDEX C = 2r/d (ROUND WIRE)
NOTE: (THE FACTOR K INCLUDES BOTH THE EFFECTS OF CURVATURE AND DIRECT SHEAR; THE FACTOR Kc INCLUDES STRESS CONCENTRATION EFFECTS DUE PRINCIPALLY TO CURVATURE.)

Fig. 4—Curve for computing correction factors in helical compression or tension springs

(1) should be multiplied by a factor K greater than unity, giving

$$s = K\,\frac{16\,Pr}{\pi d^3} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

where

$$K = \frac{4c-1}{4c-4} + \frac{0.615}{c} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

and $C = 2\,r/d$ spring index.

This formula, which was derived by approximate analytical methods, was checked by strain measurements on actual springs using sensitive extensometers[3]. One such test is that shown in *Fig.* 3 which

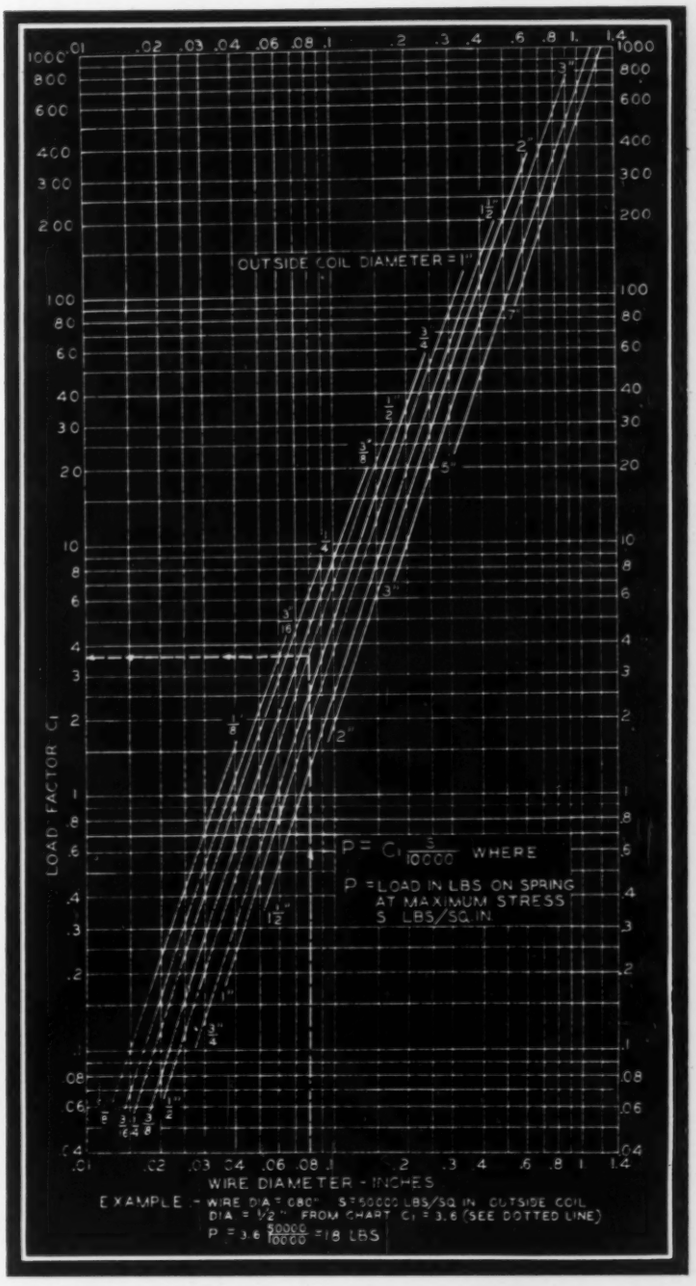

OUTSIDE COIL DIAMETER = 1"
LOAD FACTOR C1
P = C1 S/10000 WHERE
P = LOAD IN LBS ON SPRING AT MAXIMUM STRESS
S LBS/SQ IN
WIRE DIAMETER - INCHES
EXAMPLE - WIRE DIA = .080" S = 50000 LBS/SQ IN OUTSIDE COIL DIA = 1/2" FROM CHART C1 = 3.6 (SEE DOTTED LINE)
P = 3.6 50000/10000 = 18 LBS

Fig. 5—Chart for obtaining load factor in helical compression or tension springs of round wire

indicates the method of clamping the extensometer to a helical compression spring. A further check of this formula was obtained by the results of more exact calculations, based on the theory of elasticity, which indicate that equation (4) is correct within 2 per cent for spring indices greater than 3 which includes most practical springs[4]. It should be noted that these formulas do not apply to open-wound helical springs where the pitch angle is greater than about 12 degrees, but these are seldom used in practice[5].

Values of factor K are plotted against spring in-

3. See author's paper, *Transactions* A.S.M.E., APM 51-17, 1929.

4. "Die Berechnung von Schraubenfedern", by O. Gohner, *Zeit.* V.D.I. Mar. 12, 1932.

5. For calculating such springs see article by Gohner (footnote 4).

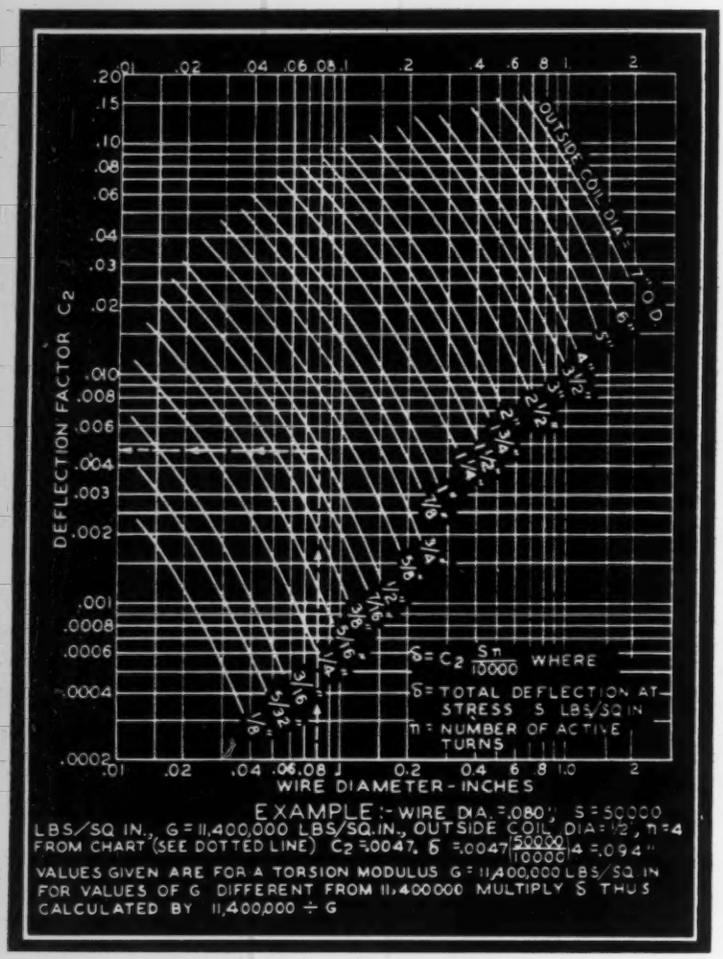

DEFLECTION FACTOR C2
WIRE DIAMETER - INCHES
OUTSIDE COIL DIA.
δ = C2 Sn/10000 WHERE
δ = TOTAL DEFLECTION AT STRESS S LBS/SQ IN
n = NUMBER OF ACTIVE TURNS
EXAMPLE:- WIRE DIA. = .080" S = 50000
LBS/SQ IN., G = 11,400,000 LBS/SQ.IN., OUTSIDE COIL DIA = 1/2", n = 4
FROM CHART (SEE DOTTED LINE) C2 = .0047, δ = .0047 50000/10000 4 = .094"
VALUES GIVEN ARE FOR A TORSION MODULUS G = 11,400,000 LBS/SQ IN
FOR VALUES OF G DIFFERENT FROM 11,400000 MULTIPLY S THUS
CALCULATED BY 11,400,000 ÷ G

Fig. 6—Chart for obtaining deflection factor in helical compression or tension springs of round wire

dex in *Fig.* 4. It may be seen from this curve that at large values of spring index, the factor K tends to approach unity. This is to be expected, since at large indices the spring more nearly approximates a round bar under torsion.

In what follows it will be found convenient to split the factor K given by equation (4) into two parts, thus:

$$K = K_s K_c \quad \ldots\ldots (5)$$

where K_s is a factor which takes into account the additional stress due to the *average* effect of the direct shear produced by the axial load and K_c is a factor which takes into account stress concentration effects principally due to wire curvature. The factor K_s cannot be considered as a stress concentration factor. It may be shown by assuming the direct shear stress due to the axial load as uniformly distributed over the cross section of the wire, that:

$$K_s = 1 + \frac{0.5}{c} \quad \ldots\ldots (6)$$

where c is the spring index and

$$K_c = \frac{K}{K_s} = \frac{K}{1 + \frac{0.5}{c}} \quad \ldots\ldots (7)$$

The factor K_c which is utilized in later calculations is given as a function of c by the curve marked K_c in *Fig.* 4.

To simplify the application of equations (2) and (3) in practical design the charts of *Figs.* 5, 6 and 7 (which are based on these equations) have been prepared[6]. They enable the designer to make a rapid calculation of load or deflection when the working stress is known. (The choice of working stresses for various types of spring applications will be discussed later.)

To compute the permissible load on the spring, the factor C_1 is first obtained from *Fig.* 5 by finding the intersection of the vertical ordinate representing the wire diameter and the curve representing the outside coil diameter. (See example and dotted line on chart.) Interpolation may be necessary for intermediate dimensions. The load P on the spring at a given stress s is found by multiplying C_1 by the ratio: $(s/10{,}000)$. Thus $P = C_1(s/10{,}000)$. The formula may also be used to find the stress at a given load: $s = 10{,}000\ (P/C_1)$.

Likewise to compute the total deflection of a spring at a given stress, the factor C_2 is obtained from *Fig.* 6, using the known wire diameter and outside coil diameter (see example on chart). The curves shown are based on a modulus of elasticity in torsion $G =$ 11,400,000 pounds per square inch which approximates the actual value for ordinary carbon steel springs. Hence for such springs, to find the total deflection δ at a stress s the value of C_2 thus found is multiplied by the ratio $s/10{,}000$ and by the number of active turns n. Thus $\delta = C_2\ (s\,n/10{,}000)$. Conversely, if δ is known, $s = 10{,}000\ (\delta/C_2 n)$. The deflection *per active turn* is given by $C_2(s/10{,}000)$. In cases where the torsion modulus is different from 11,400,000 pounds per square inch (as for some kinds of alloy steel, phosphor bronze, or severely cold worked carbon steel springs) the value of the deflection δ thus computed must be multiplied by the ratio 11,400,000/G where G is the actual modulus. Thus in the example given in the chart where $\delta = 0.094$ inch, if the torsion modulus G is 10,000,000 pounds per square inch the total deflection δ will be (11,400,000/10,000,000) $0.094 = 0.107$ inch.

To compute the load P at any given deflection δ, the chart of *Fig.* 7 may be used. This chart yields the factor C_3 in the formula

$$P = C_3\delta/n. \quad \ldots\ldots (8)$$

6. See author's article "Helical Compression and Tension Springs", Design Data section, *Journal of Applied Mechanics, Transactions* A.S.M.E., March, 1936. Also article by Whiting, MACHINE DESIGN, February, 1936.

7. See "Model Testing as Applied to Strength of Materials", by R. E. Peterson, *Transactions* A.S.M.E. 1933, APM 55-11 for discussion of "size effect".

where n = number of active turns. The factor C_3 may be taken from the chart when the outside coil diameter and wire diameter are known (see example on chart). It may be seen that C_3/n is equivalent to the spring constant of the spring, i.e. the load per inch of deflection.

It should be noted that there will always be some inaccuracy in reading the charts of *Figs.* 5, 6 and 7, particularly if interpolations are made. Hence if high accuracy is necessary, springs should be calculated by equations (2) and (3). It should be noted, however, that because of unavoidable commercial variations in coil diameter and wire size, and because of inaccuracy in estimating the effect of the end turns, the actual deflection of the spring will usually deviate by several per cent from the calculated, unless special precautions in manufacturing have been taken.

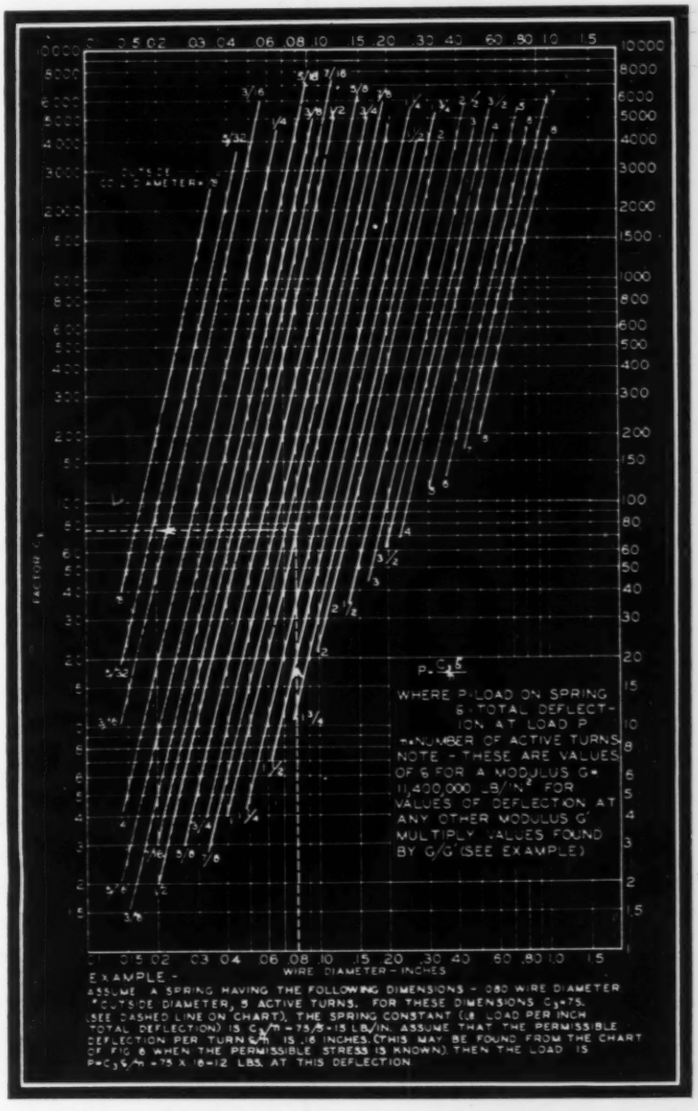
EVALUATION OF EFFECT OF SPRING INDEX ON CHOICE OF WORKING STRESS (Sensitivity Index $q=1$). Using the general method for determining working stress described in Part I, the effect of spring index c on the choice of working stresses may be evaluated. Fatigue tests on specimens having stress concentration show that in general there is a "size effect" such that the full effect of stress concentration is not as great as would be expected from theoretical considerations alone. In addition, it has been found that certain materials, particularly the fine-grained high-strength alloy steels, are relatively more sensitive to stress concentration than are the coarse-grained, medium carbon steels. Such alloy steels will show the full effect of stress concentration in relatively small specimens. The sensitivity to stress concentration may be taken into account by introducing a "sensitivity index" q, which is[8]

$$q = \frac{K_f - 1}{K_c - 1} \qquad \text{.....(9)}$$

where K_c is the theoretical stress concentration factor (due mainly to wire curvature) and K_f the "effective stress concentration factor" as determined by fatigue tests. Thus if the material is not sensitive to stress concentration $K_f=1$ and $q=0$, from equation (9), while if the material is very sensitive $K_f=K_c$ and $q=1$. The sensitivity index q thus varies from zero to unity depending on the degree to which the material responds to the effect of stress concentration. In general it will be found that for the smaller sized specimens and for medium carbon steels, q will be less than unity. Thus fatigue tests on specimens with fillets[8] indicate that for medium carbon steels and ¼ inch diameter specimens, values of q as low as 0.5 may be found. For high-strength alloy steels, a value of q approximately 0.9 may be found for specimens around ⅜ inch in diameter.

Since very little test data are at hand for determining q on actual spring wires, in this paper it will be assumed that $q=1$, i.e. that the full stress concentration effect due to wire curvature is present insofar as the variable stress is concerned, an assumption which should give results on the safe side. (A discussion of methods for taking into account cases where q is less than 1 is given in the following). It will also be assumed that the tensile and fatigue properties of the material are the same for a given wire diameter regardless of wire curvature, and that the spring is under a working stress range from s_{min} to s_{max} in fatigue. (These stresses may be figured from the range in load or deflection using equations (2) and (3) or the charts of *Figs.* 5, 6 and 7). Then from equation (1) of Part I, which is based on straight line relationship between the static and variable stresses

Fig. 7—Chart for determining loads at given spring deflections in helical compression or tension springs. Note: For best accuracy in determining loads or deflections, equation (2) should be used


WHERE P=LOAD ON SPRING
δ=TOTAL DEFLECTION AT LOAD P
n=NUMBER OF ACTIVE TURNS
NOTE - THESE ARE VALUES OF δ FOR A MODULUS G=11,400,000 LB/IN.² FOR VALUES OF DEFLECTION AT ANY OTHER MODULUS G' MULTIPLY VALUES FOUND BY G/G' (SEE EXAMPLE)
WIRE DIAMETER - INCHES
EXAMPLE -
ASSUME A SPRING HAVING THE FOLLOWING DIMENSIONS - .080 WIRE DIAMETER
OUTSIDE DIAMETER, 5 ACTIVE TURNS. FOR THESE DIMENSIONS C₃=75.
(SEE DASHED LINE ON CHART). THE SPRING CONSTANT (LB LOAD PER INCH TOTAL DEFLECTION) IS C₃/n = 75/5 = 15 LB/IN. ASSUME THAT THE PERMISSIBLE DEFLECTION PER TURN δ/n IS .16 INCHES. (THIS MAY BE FOUND FROM THE CHART OF FIG 8 WHEN THE PERMISSIBLE STRESS IS KNOWN). THEN THE LOAD IS P=C₃δ/n = 75 X .16 = 12 LBS. AT THIS DEFLECTION

8. See "Two- and Three-Dimensional Cases of Stress Concentration and Comparison with Fatigue Tests", by Peterson and Wahl, *Transactions* A.S.M.E., March, 1936, (*Journal of Applied Mechanics*) and December, 1936 for a discussion of "sensitivity index".

contributing to failure, we have

$$\frac{s_{wo}}{s_y} + \frac{s_{wv}}{s_e} = \frac{1}{N} \quad \ldots\ldots (10)$$

where s_{wo} and s_{wv} are the static and variable components of the working stress, N the factor of safety, and s_y and s_e are the yield point and endurance limit of the material *in shear*[9].

In line with the discussion in Part I, stress concentration effects due principally to curvature in helical springs (represented by the factor K_c in the equation $K=K_sK_c$ of equation (5)) will be neglected in figuring s_o. Hence the static stress:

$$s_{wo} = \frac{s_{max} + s_{min}}{2\,K_c} \quad \ldots\ldots (11)$$

(Since s_{max} and s_{min} are figured by using the factor K which includes both direct shear and curvature effects, division by K_c is necessary if stress concentration effects due to curvature are neglected). Also, the variable stress:

$$s_{wv} = \frac{s_{max} - s_{min}}{2} \quad \ldots\ldots (12)$$

Substituting equations (9) and (10) in (8) we find

$$s_{max} = \frac{\frac{2\,s_y}{N}}{\frac{1}{K_c}\left(1+\frac{s_{min}}{s_{max}}\right) + \frac{s_y}{s_e}\left(1-\frac{s_{min}}{s_{max}}\right)} \quad \ldots\ldots (13)$$

where K_c is given by equation (7) or *Fig.* 4.

This equation is not very convenient for computing helical springs since s_e, the endurance limit for *reversed* torsion fatigue stressing, is not usually known, particularly for wires having a surface corresponding to that in the actual spring.

In order to obtain a more usable form, we assume that the endurance limit in pulsating torsion (0 to maximum) for a spring of large index is known. This quantity, denoted by s'_e, can be determined by actual test. If s'_e is known then the point P on the experimental curve of *Fig.* 8 is given since both the static and variable stress components s_o and s_v are equal to $s'_e/2$ for this type of stress application. This may be seen from equations (11) and (12) since $K_c=1$ when c is large. For simplification, we replace the true experimental curve, represented by the dashed line, on *Fig.* 8, by the straight line PA. Using equations (11) and (12), it may be shown from this figure that:

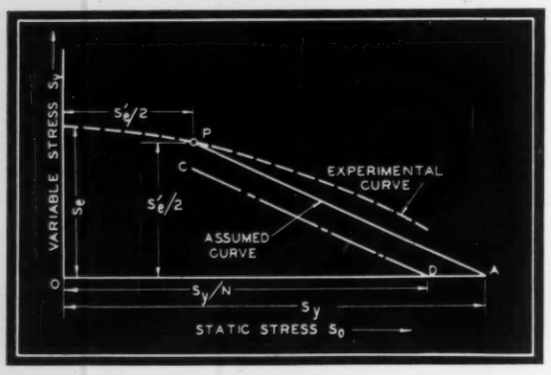
$$s_{max} = \frac{\frac{2\,s_y}{N}}{\frac{1}{K_c}\left(1+\frac{s_{min}}{s_{max}}\right) + \left(\frac{2\,s_y}{s'_e}-1\right)\left(1-\frac{s_{min}}{s_{max}}\right)} \quad \ldots\ldots (14)$$

where points which fall on the line CD parallel to PA and intersecting the axis of abscissas at a distance s_y/N from the origin O are defined to have a factor of safety of N[10]. In this equation s_{max} is the maximum allowable shearing stress, assuming a factor of safety N. This equation may be written:

$$s_{max} = C_w s'_e/N \quad \ldots\ldots (15)$$

where C_w is a function of K_c, s_{min}/s_{max}, and s_y/s'_e. Since K_c is a function of the spring index c, equation (7), the factor C_w may be plotted graphically in the form of charts, as shown on *Figs.* 9, 10 and 11. In these figures C_w is plotted as a function of s_{min}/s_{max} for various spring indices, each chart representing a definite value of s_y/s'_e where s'_e is the endurance limit in pulsating (O to maximum) torsion, made by tests on springs of large index[11]. The values of

Fig. 8—Application of straight line law to helical springs when endurance limit for pulsating load application (zero to maximum) and yield stress are known. (All stresses are torsion stresses)



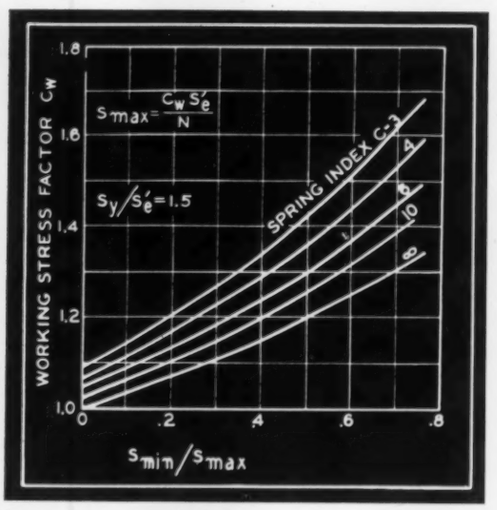


Fig. 9—Chart for working stress factor where yield stress over endurance limit for pulsating stress is 1.5 and sensitivity index is 1 (Helical compression springs)

9. In Part II, the symbol N will be used for factor of safety, n being retained to represent number of turns.

10. It is assumed that the static component of stress is always equal to or greater than, the variable component.

TABLE I

Spring Index	Limiting Stresses* from Zimmerli's Fatigue Tests		Limiting Stresses† (Calculated from Charts of *Fig.* 9)		Limiting Range in Stress ($s_{max} - s_{min}$)	
					By Test	Calculated (*Fig.* 9)
C	s_{min}	s_{max}	s_{min}	s_{max}		
3.5	14,000	100,000	14,000	95,500	86,000	81,500
4.55	19,000	94,000	19,000	96,000	75,000	77,000
7.0	19,000	93,000	19,000	93,500	74,000	74,500
9.1	19,000	90,000	19,000	92,000	71,000	73,000
11.9	19,000	91,000	19,000	91,000	72,000	72,000

* These stresses calculated using the K-factor of *Fig.* 4.
†$s'e$ taken as 82,700 pounds per square inch.

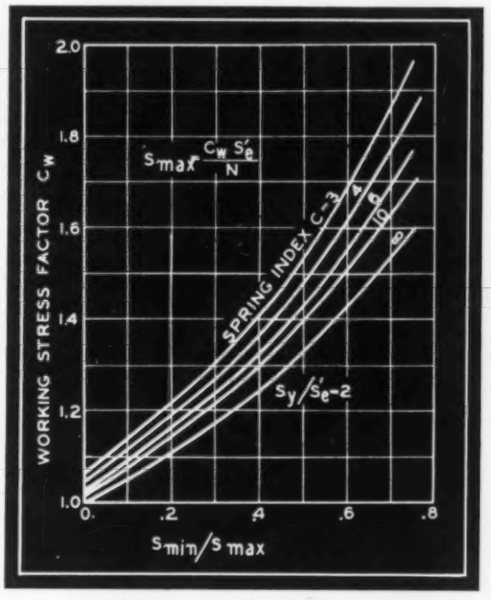


Fig. 10—Chart for working stress factor where yield stress over endurance limit for pulsating stress is 2 and sensitivity index is 1 (Helical compression springs)

s_y/s'_e=1.5 (*Fig.* 9), 2.0 (*Fig.* 10) and 2.5 (*Fig.* 11) cover the range of most practical values. Interpolation between results obtained for values of s_y/s'_e differing from these may be made with sufficient accuracy for practical use.

As may be seen from these curves, for a large range in stress, i.e. s_{min}/s_{max} near zero, the value of C_w varies from 1 for a spring with a large index ($c=\infty$) to 1.05 to 1.10 for a spring with small index (c=3) the value depending on s_y/s'_e. This means that under these assumptions (where the sensitivity index q=1) almost the full stress concentration effect of the factor K should take place. On the other hand, where the range is small (i.e. s_{min}/s_{max} approaches unity) much higher values of C_w are obtained for the smaller indices. Thus for s_y/s'_e=1.5, for s_{min}/s_{max}=.75 a value C_w=1.68 is obtained for a spring of index 3 as compared with 1.42 for a spring with an index 10.

Example of Application of Charts

As an example in the application of the charts of *Figs.* 9, 10 and 11, let us assume that we have a spring of ¼-inch wire diameter and ¾-inch mean coil diameter, i.e. c=3. Assume tests on springs of large index for this size wire yield a value s'_e=60,000 pounds per square inch, while torsion tests show s_y=120,000 pounds per square inch. Thus s_y/s'_e=2.0 and the chart of *Fig.* 10 should be used. Assume a factor of safety N=1.5 [12]. If s_{min}/s_{max}=½, i.e. a range from half the maximum to the maximum, from the chart of *Fig.* 10 for c=3, we find C_w=1.53. The

(*Continued on Page* 72)

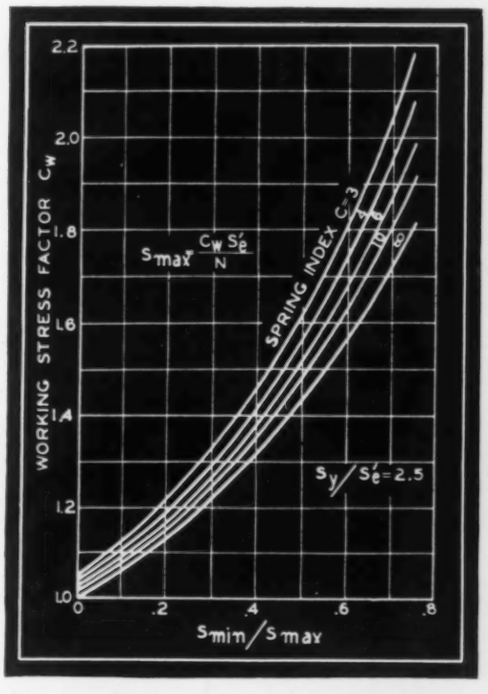


Fig. 11—Chart for working stress factor where yield stress over endurance limit for pulsating stress is 2.5 and sensitivity index is 1 (Helical compression springs)

11. It should be noted that $S'e$ and Sy must correspond to values obtained on the wire size being considered since in general these values will change with wire diameter.

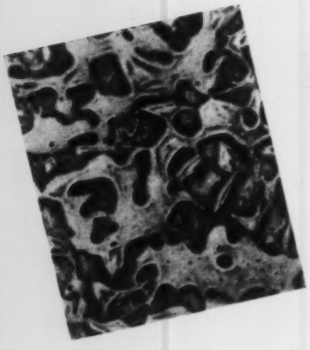
12. Considerations governing the choice of the factor of safety N were discussed in Part I.

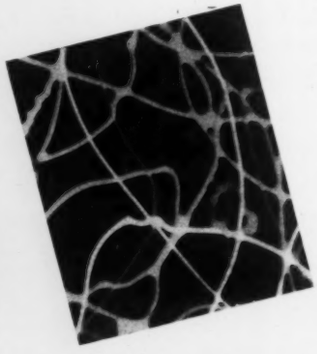
Surface Finishes Enhance Sales Possibilities

CHOOSING a finish for a machine involves a great many factors, not the least of which is sales appeal. Will the finish adhere well to the surface of the material? Will it protect the machine under conditions encountered in service? Will it retain its attractiveness during packing, shipping, delivery and installation? These and many other questions involve too wide a scope to cover fully in this article. However, there are many new, unusual and pleasing finishes which are particularly suitable for certain applications, a discussion of which may help designers in their consideration of machine finishes.

Machines which must be produced on a fast schedule can be designed to take the newly-developed polymerizing enamels which give a tough, hard, yet flexible coating with a bake time ranging from a few minutes to a few seconds.

Modern lubricating oils contain rust-inhibiting substances which react with ordinary lacquers with subsequent discoloration. This can be eliminated by specifying a new clear lacquer immune to rust inhibitors and also resistant to humidity, salt spray and chemicals. It withstands stamping and forming operations, also. For parts which must undergo considerable handling such as control levers, another lacquer is available especially resistant to perspiration. Grades suitable for finishing copper, brass and aluminum are supplied. A special air-drying enamel can be used to finish wood, fiber, wall board, cardboard and other materials with a surface resembling slate. It takes chalk marks like slate, and an ordi-



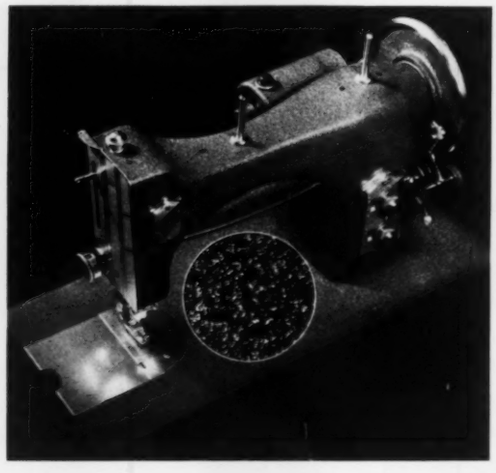


Upper left, stipple finish with large figures

Upper right, marbleized lacquer in three colors on a black base

Lower right, imitation wood grain finish

Wrinkle finish reduces work required in smoothing casting. Photo courtesy White Sewing Machine Co.



In one hour, 4320 watches like these can be sprayed flawlessly

nary blackboard eraser will remove the marks.

Chromium, notably difficult to lacquer, can be given a coat of a new lacquer which adheres tenaciously to the metal, forming an excellent base for any kind of lacquer enamel. It resists heat, remains flexible and permits the metal to be engraved after it has been applied. Aluminum parts may use the newer synthetic lacquers having a brilliant initial luster and a tough film that withstands considerable punishment.

White baking enamels have been improved so they are suitable for use where color retention, resistance to marring, extreme hardness and durability are important factors. Synthetic resin enamels for protection against corrosion also have been developed.

For business machines and other much-handled equipment, a synthetic baking enamel is available possessing the unique property of concealing scratches, fingerprints, dust and smudges. This finish does not chip, mar, flake or peel and so reduces damage from rough handling.

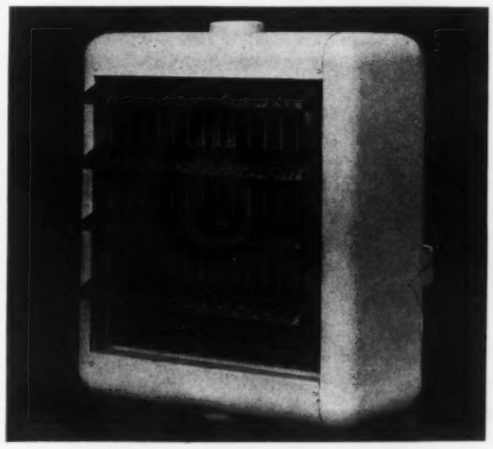
It is often desired to give rubber or other non-metallic parts for machines a metallic finish to harmonize with metals with which they may be used. A strongly adherent finish resembling brass, copper, bronze, aluminum, steel or other metals has been developed to cover semi-stiff rubber. Conversely, a rubber finish is often desired on metal surfaces, especially in connection with electrical equipment. This need has recently been filled by a new black enamel which dries to a rubber finish. It is tough and durable as well as having specially high dielectric strength.

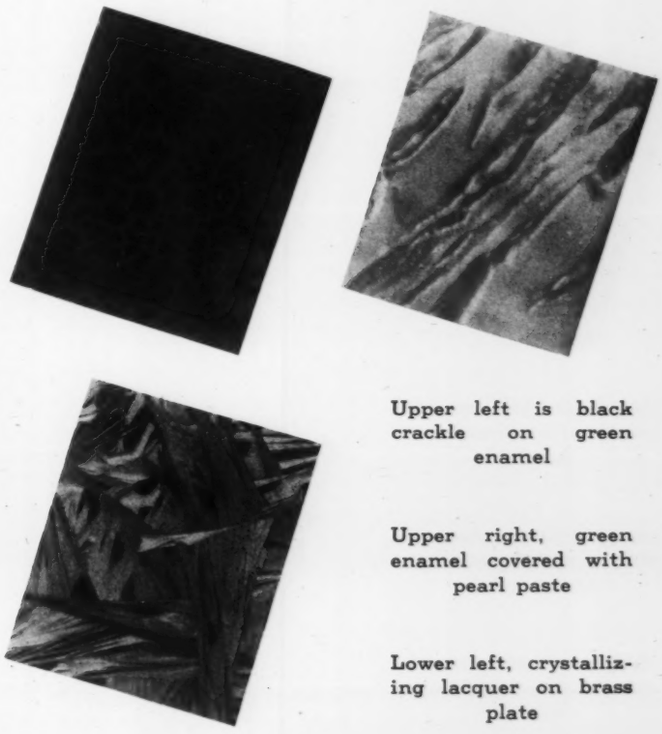
Anti-icing paint for surfaces upon which ice must be kept from forming, such as airplane parts, is a European development of significance.

Imitates Hammered Metal

Of the numerous novelty finishes, there is a new finish that looks like hammered metal. It can be applied to wood, metal, paper, composition board, or molded plastics. Of particular value for items where a smooth, soft finish is desirable is the imitiation suede leather finish. This is produced by spraying

A colorful, rich finish of unusual texture Hiding minor surface imperfections, it eliminates costly polishing





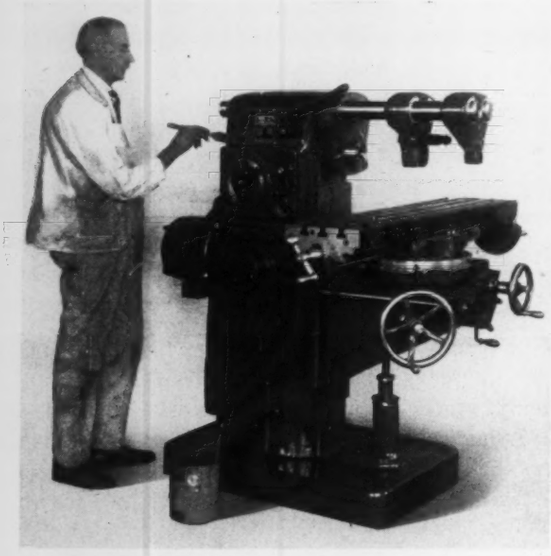
Upper left is black crackle on green enamel

Upper right, green enamel covered with pearl paste

Lower left, crystallizing lacquer on brass plate

finely divided cotton or rayon on a ground coat while it is sticky. Cracking finishes which expose another color underneath it are available in wide variety. Several new wrinkle finishes have also been developed with controlled patterns and textures. Fatty edges, flashes and variations have been eliminated. These finishes are especially useful on items where the surface is not smooth such as on castings.

Simulated wood finishes processed from photographic plates can be used to imitate perfectly any grain or grain design. Decalcomanias or gelatin transfers make possible lustrous marble imitations on metal which almost defy detection. Lithographing on metal sheets, subsequently formed and assembled, is one of the outstanding production methods employed in finishing.



A synthetic sealer coat, highly resistant to cutting oils, compounds, etc., is applied over the sanded filler coat as protection during assembly and test. Breaks and blemishes are puttied and covered with white shellac. Finish coat is synthetic enamel

Electroplated parts need no longer be colorless as a new process of plating makes a full range of colors available. The color is obtained by diffraction through a very thin layer, the thickness of the layer determining the color. In fact, the colors run through the spectrum as the deposit is built up and repeat as the deposit becomes thicker.

Die casting finishes well past the development stage include bright nickel, synthetic resins and various lacquers. A recent advance is the application of wood-grain, marbleized and similar films cemented over an enamel undercoat much like decalcomanias. Covered with clear lacquer, striking results can be obtained. Zinc and aluminum die castings can be finished in any desired color or gloss just as they come from the molds provided the surfaces are clean and free from scale as a new finish makes possible elimination of the surface treatment operation formerly necessary to assure adherence of surface films.

A new process has also been developed for coating die castings by molding them under a bakelite surface. This promises to have considerable possibilities for many applications in die casting work. Aluminum alloy die castings can be baked at relatively high temperature and even vitreous enamel applied as they have a relatively high melting point. Magnesium base die castings usually require an organic finish.

Prefinished Metals Widely Available

In any discussion of finishes, the use of prefinished metals cannot be overlooked as this field is rapidly assuming considerable importance. Prefinished sheets and strip in a wide variety of metals, colors and finish designs are available, suitable for moderate forming and stamping operations. Finish is protected by a removable paper coating on some types. An adhesive-backed prefinished metal which can be applied directly to wood, cardboard, plastics and similar materials is also available.

From this outline it is evident that a broad range of special finishes is now at the designer's convenience. Since the sales appeal of a machine depends so much upon the finish, the importance of adequate care in its selection cannot be underestimated.

MACHINE DESIGN wishes to thank the following companies for their assistance in the prepaartion of this article: Hercules Powder Co. Inc., Wilmington, Del.; Maas & Waldstein Co., Newark, N. J.; Monsanto Chemical Co., St. Louis; Oxford Varnish Corp., Detroit; Roxalin Flexible Lacquer Co., Elizabeth, N. J.; Society of Automotive Engineers, New York City; The Arco Co., Cleveland; The Glidden Co., Cleveland; The New Jersey Zinc Co., New York City; The Sherwin-Williams Co., Cleveland.

Articles on this and allied subjects published in previous issues of MACHINE DESIGN include:

"Evolution in Finishing Processes Worthy of Designer's Study," by M. J. Callahan, May, 1930, p. 46.

"Is It Possible to Standardize Machine Finishes?" Dec., 1931, p. 22.

"Improving Design with New Finishes," by William J. Miskella, Oct., 1932, p. 37.

"Porcelain Affords Protective Coating," Nov., 1932, p. 23.

"Sprayed Metal Offers Possibilities," Dec., 1932, p. 21.

"Metallic Coatings Combat Corrosion and Provide Attractive Finish," by Gustaf Soderberg, April, 1933, p. 18.

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"Prefinished Sheets Extend Design Limits," by Harold B. Veith, Nov., 1934, p. 27.

"Protecting Machine Parts by Metal Spraying," by Harold B. Veith, Feb., 1935, p. 28.

"Color—A Review of Three Notable Monographs," Dec., 1935, p. 26.

"Metal Show Stars Materials and Finishes," Nov., 1936, p. 45.

"Color and Sales Are Closely Linked," by R. H. Hookway, Feb., 1937, p. 44.

"Rubber Affords Protection for Machine Parts," by Fred Kelly, May, 1937, p. 5.

"Chrome Plating Combats Wear," by Fred Kelly, June, 1937, p. 34.

For earlier articles, see listing page 32 of MACHINE DESIGN, July, 1934.

Fluid Flow Analogy for Torsional Stresses

By R. C. Binder

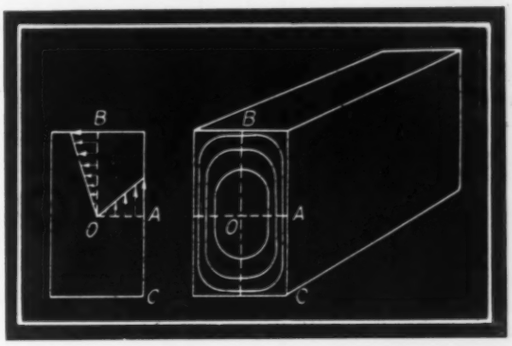


Fig. 1—Rectangular bar subjected to a twisting moment

MENTAL pictures of stress distributions frequently prove of considerable aid to the machine designer. A rather easily applied analogy, involving fluid flow theory, is helpful in the study of stresses due to torsion.

Designers are quite familiar with the simple stress distribution in a uniform circular bar subjected to a twisting moment, in which the stress varies directly as the radius from the center of the section. The cases of rectangular, triangular and elliptical sections, and sections having notches or holes, however, are more complicated and difficult to calculate. An interesting fluid flow analogy, called Kelvin's hydrodynamical analogy, can be applied to these complicated cases. This fluid flow analogy has the advantage of giving a mental picture of the stress distribution and of easily giving a qualitative answer to many problems concerned with fillets, keyways, and desirable sections.

METHODS of visualizing stresses in machine members always are of interest to design engineers. In MACHINE DESIGN for April, 1937, a similar discussion to the one presented herewith was published. That dealt with principle stresses, however, while the current article covers stresses due to torsion. The author is assistant professor of mechanical engineering at Purdue university

In any section of a uniform bar subjected to a twisting moment imagine a frictionless fluid (no viscosity) circulating with uniform angular velocity. The shear stress at any point corresponds to the linear velocity of the circulating fluid at that point. As an example, consider a uniform rectangular bar subjected to a twisting moment. Referring to *Fig.* 1, imagine a circulation of fluid in the section around the center *O*. At the section *OA* the linear velocity varies directly as the distance from the center *O*, the highest value being at the point *A*. Since the same amount of fluid passing line *OA* must pass line *OB*, the velocity at *A* is greater than at *B*. The maximum shear stress is then at *A*. There is no shear stress at corner *C* because no fluid is flowing there. Likewise, in a triangular section there is no fluid flow and hence no shear stress at the corners of the triangle.

Application of this analogy to a bar of elliptical cross section shows that at the ends of the minor axis the shear stress is greater than at the ends of the major axis.

The value and location of fillets is indicated by this fluid flow analogy. Referring to *Fig.* 2, at the right-angle corners *G* of the keyway the velocity of the fluid becomes very large, and plastic deformation might occur. Fillets at corners *G* would be of much value, especially if the stress were reversed. Fillets at corners *F*, on the other hand, would not be important, for the fluid velocity and, hence, the shear stress is zero. The same reasoning applied to the cross shown in *Fig.* 3 would indicate a dangerous region at *E* and no shear stress at *D*.

Applying this flow analogy to the circular section, the flow lines, or streamlines (lines giving the veloc-

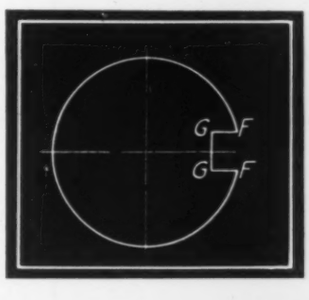


Fig. 2—Circular section of bar with keyway subjected to a twisting moment

ity direction), become concentric circles. If there is a notch, hole or crack in the circular section the streamlines are crowded on the radial sides of the obstruction in the circulating stream. Referring to *Fig.* 4, at *H* the velocity is zero; therefore the stress is zero. At *L* and *K* the streamlines are crowded, the

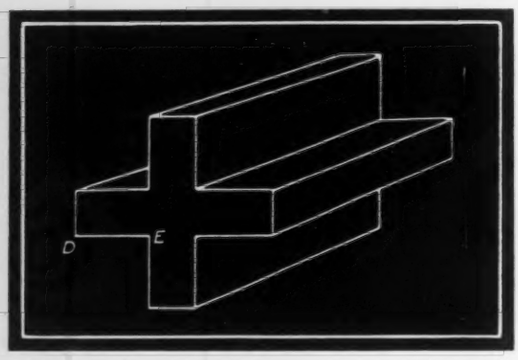


Fig. 3—Bar whose section is a cross subjected to a twisting moment

velocity of the fluid is increased and the shear stresses are increased. This points to the danger which might exist if a radial crack or notch is present in a circular section.

It is believed that Coulomb was the first to give a solution of the torsional problem of the solid or hollow circular cylinder. St. Venant pointed out that Coulomb's solution does not hold for sections of prisms other than the circular, and St. Venant worked out the mathematical solution for a good number of sections such as elliptical, rectangular, star and triangular. Lord Kelvin and Tait later pointed out the hydrodynamical analogy, showing that the torsional problem of bars of uniform section is mathematically identical to the motion of a frictionless

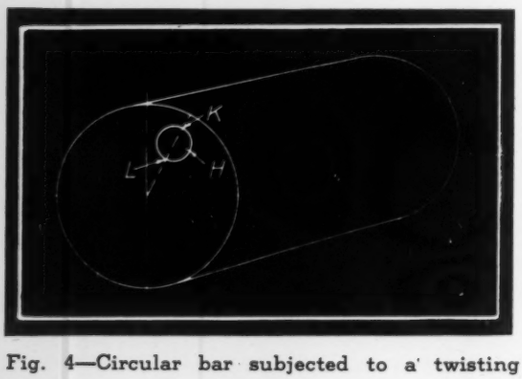


Fig. 4—Circular bar subjected to a twisting moment

fluid in a box the same as the section of the bar. The treatment by Lord Kelvin and Tait pictured a shell of the section filled with fluid. A couple is applied to the box in a plane perpendicular to its length. The same relative motion is obtained by considering the box fixed and the fluid moving.

For an actual analysis of complicated sections in torsion, references to calculations and experiments should be made, but for a quick mental picture in many design considerations this fluid flow analogy is of considerable convenience and help.

Prandtl presented a membrane analogy which is also very helpful. Imagine a membrane having the same outline at the cross section as the uniform bar being twisted. The membrane is held at the edges with a uniform tension, and loaded uniformly over its area. Besides other characteristics, the maximum slope of the deflected membrane at any point corresponds to the shear stress in the twisted bar at that point. Referring to *Fig.* 1, if the rectangular membrane is loaded the slope at points *C* and *O* would be zero, while at the point *A* it would be a maximum. This is the same result that would be obtained from the fluid flow analogy.

Designing for Castings

SHALL a part be made of cast steel, malleable or gray iron, welded structurals or of nonferrous metals? Each case requires a determination of which one will serve best considering all factors involved without prejudice or personal predisposition. The amount of judgment exercised in the choice of materials and methods of construction is the distinguishing factor between the ordinary and the highly successful designer, according to Raymond L. Collier, Cleveland, O., who emphasizes the following points.

The designer must constantly cultivate the receptive and open mind as one previously unsatisfactory experience with a certain method does not mean it should receive no further consideration nor should a method be used just because it worked well on another instance.

The selection of materials is usually a compromise. Whereas one material may impart a higher ultimate strength, another a higher yield point, a third may more nearly possess the impact resistance desired. Other factors such as resistance to corrosion, abrasion and high or low temperatures may also be involved, all of which must be considered and balanced by the designer.

Some years ago when the recent movement toward welded construction began, engineers emphasized the importance of wiping the slate clean, so to speak, in approaching the design of welded structures, a sound policy. The same holds true in designing a steel casting as it is a known fact that most steel casting failures are due to improper design.

After evaluating all elements, the designer should divorce himself from precedent and design his structure in a way best suited to the process and material selected, working closely with those who are to do the actual production work.

Recessed Screws — Stitching — Machine Riveting

By Guy Hubbard

Fig. 1 — Above — Power driving of recessed-head screws, showing how this type of screw is carried on and guided by its special four-fluted driver

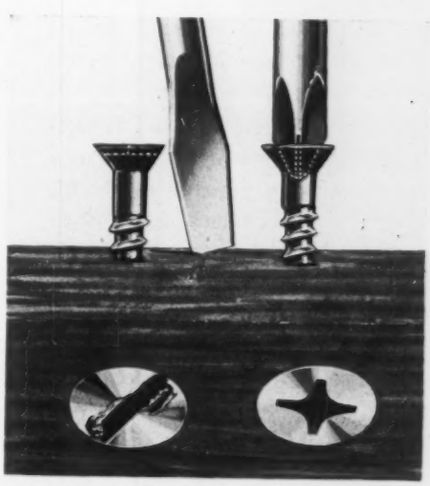
DEVELOPMENTS in mechanical fastenings which make for their quicker and more effective application in connection with product assembly operations, are fully as important as those developments having to do with engineering elements such as threads. A classic example in support of this statement is furnished by the sweeping influence of the "socket head" idea in connection with cap and set screws. That particular subject was dealt with to some length on Pages 36, 37 and 38 in February, 1937, issue of MACHINE DESIGN.

Distantly related perhaps to the socket heads but of much more recent conception, radically different design and affecting an almost entirely different division of the screw family, is the Phillips recessed, self-centering head. This patented head, shown at the right in *Fig.* 2, has been designed as an improvement for those screws which are applied by means of hand or power screw drivers, including wood screws, hardened sheet metal screws, stove bolts and smaller sizes of machine screws.

The four-way tapered slot characterizing this system is "self-contained" in the screw head. That is, it does not break through at the edges as does the conventional single slot. Not only does this result in an unusually strong and good looking screw head, but also it eliminates entirely the dangerous and damaging slipping of the screw driver and burring or bursting of screw heads as has occurred at the left in *Fig.* 2.

These screws are designed and manufactured so that they cling to the points of their accurately formed four-fluted driver blades. This is demonstrated by the power driving operation depicted by *Fig.* 1, which, incidentally is typical of modern high speed mass assembly. Therefore driving becomes a rapid one-hand operation, very little pressure being required to hold the driver in the screw as it is run in. The snug "straight line fit" between driver and screw enables the operator to guide the screw properly even in cross-grained wood. While in an emergency these screws can be driven or removed

Fig. 2—Below—Design of the recessed, self-centering head and its special driver blade, indicating some advantages of this system in product assembly



by an ordinary screw driver, that practice is not recommended.

As likewise is true of the socket head types, these recessed head screws have very definite appearance value. For instance, in exposed locations on machinery, hardware, furniture, automotive trim, etc., the slots either can be turned so that they themselves give decorative regularity of pattern, or their recesses can readily be filled for flush finishing. A light blow on the driver will expel the filling if withdrawal is required.

Stitching Steel

Of all the methods of fastening, probably the most ancient is that of stitching. How many designers are aware that today it is possible and entirely practical to stitch cold rolled sheet steel up to .050-inch in thickness!

Like many another precedent-breaking method of fabrication, wire stitching of the heavier steel sheets originally developed in the automobile industry. This is indicated by *Figs.* 3 and 4 showing respectively one of the heavy duty stitching machines and examples of its work under production conditions.

To force a staple through steel up to .050-inch thick—at the same time using wire soft enough to clinch—admittedly was one of the toughest problems with which wire stitching engineers ever were faced. They solved it by designing their supporting and operating mechanism to an unusual degree of precision and by employing special heavy duty parts.

So rigidly is the staple supported and so forcefully is it driven that it actually punches out small disks of steel as it pushes through. The wire is fed from a coil, and while one staple is being driven and clinched (all in one operation) the next staple is being formed ready for driving. If even spacing is essential, the machine is controlled one stitch at a time by a non-repeating foot-operated clutch, but where exactness is not essential, stitching is continuous.

The scope of heavy gage metal stitching is rapidly being widened to cover many applications other than automotive. It most certainly has developed to the point where it deserves the thoughtful consideration of those responsible for the design of sheet metal assemblies for economical quantity production. This is true especially in those cases where fibre or composition tacking strips and insulating and sound-deadening sheets must be attached firmly to the metal

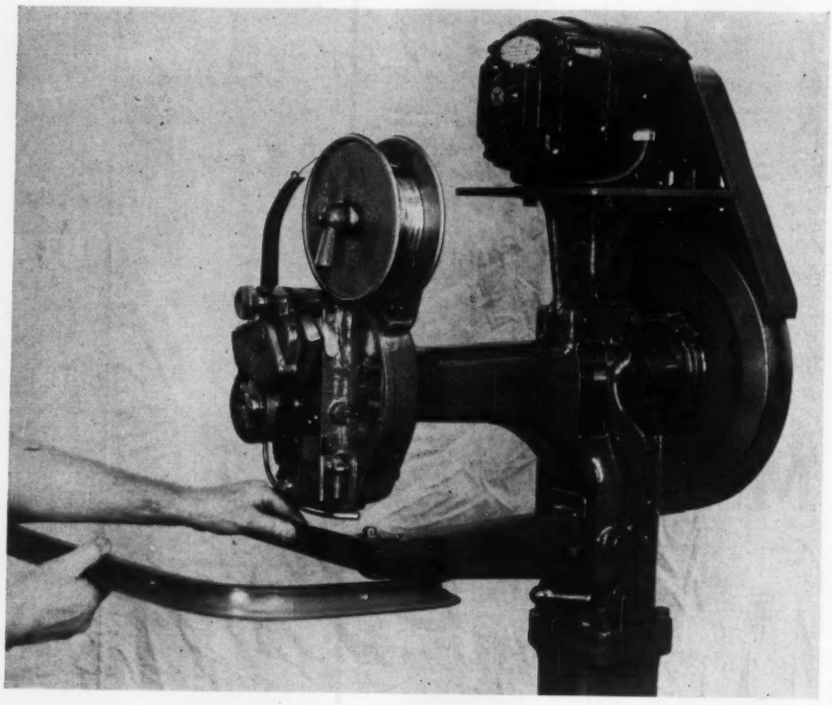
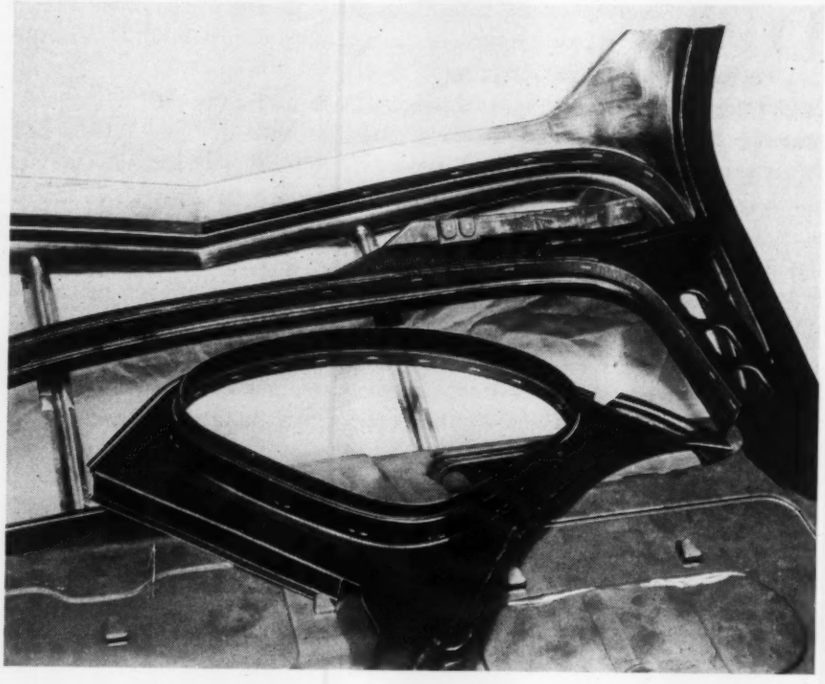


Fig. 3—Above—Heavy duty Bostitch-Bliss machine in action, wire stitching weather stripping to the steel garnish molding of an automobile window

Fig. 4—Below—Windshield frame, body panel and window frame on which wire stitching has been employed to fasten fibre tacking strips to steel



—as is increasingly common in modern design practice.

Another time-tried method of mechanical fastening is by riveting, the mention of which may bring to mind a vision of an old man at a bench painfully "heading them up" one at a time with a peen hammer. It behooves the designer to get that picture out of his mind because recent developments in a wide variety of riveting machines and improved types of rivets for use therewith, make riveting today one of the fast, economical and satisfactory methods for the permanent assembly of mechanical parts manufactured in quantities.

Select System to Suit Conditions

It is not our purpose in this article to enter into the relative merits of the different varieties of rivets such as solid, tubular, split, etc. or into the several methods of machine setting, including pressure, single blow, vibrating blow spinning and so on. Different products demand different types of rivets and riveting machines and in many instances the riveting machines already in the plant will dictate what the riveting specifications on the drawings should be.

If there is no adequate riveting equipment in the plant, the designers, the production men, and riveting machinery engineers should "get their heads together" on the riveting problems before a new design gets beyond the preliminary sketching stage. By the same token, when riveting equipment is available, the applications engineers and the production department can still be of distinct service to the designers—the latter by seeing to it that the engineering department is supplied with complete data on the working capacity, clearance, etc. of the equipment.

Here is some advice to designing engineers from one of the leading manufacturers of rivets and high speed automatic machines for setting them: "We urge that preliminary sketches be submitted for study by our engineers. Only in such cases are we able to suggest early enough those minor changes which will insure the most effective use of such equipment as for example the automatic feed machine shown in *Fig.* 5.

"Too often we are not approached until the product is out of the engineering department and in the hands of the shop man responsible for assembly. In many cases engineering estimates have been thrown completely out of line because of the discovery that the design is such that the machine which should be used cannot reach some of the rivets.

Automatic Multiple Riveting

"Few engineers appreciate the wide range of rivet calibers which can now be fed and set automatically. They range from drilled rivets less than .060-inch, up to tubular rivets ⅜-inch in body diameter. Some hopper feed machines will handle rivets nearly 4-inches long, and on special machines as many as four rivets at a time are set. The machine in *Fig.* 5 is equipped for multiple setting."

In the preparation of this article the author has received valuable assistance from: The American Screw Co.; The Apex Machine & Tool Co.; Bostitch, Inc.; and The Chicago Rivet & Machine Co. Credit also is due these companies for illustrations used herewith.

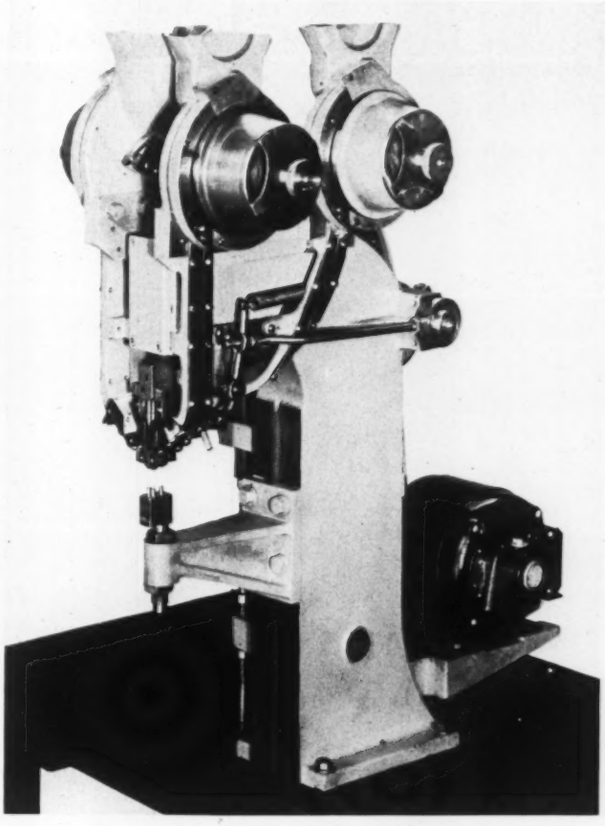


Fig. 5—Motor driven bench machine with three rotary hoppers, tooled for setting three rivets at once

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Articles on this and allied subjects published in previous issues of MACHINE DESIGN include:

"Stress in Riveted and Screwed Fastenings," by John V. Martenis, Nov. 1929, p. 13.

"Designing Bolts for Shock Loads," by J. I. Clower, Sept., 1931, p. 36; also by E. S. Ault, Oct., 1931, p. 53.

"Timesavers Aid Busy Designers," by Karl A. Eckhardt, Oct., 1931, p. 53.

"Machine Fastenings May Spell Failure or Success," by Harold B. Veith, July, 1932, p. 32.

"Avoiding Fine Screw Systems," March, 1934, p. 21.

"Determining Efficiency of Differential Screws," by A. R. Kligman, April, 1934, p. 26.

"Thread Representation Confusing," by J. Nicholson, Oct., 1934, p. 41.

"Failures of Machine Parts Show Needed Design Changes," by Franklin L. Everett, April, 1935, p. 33.

"Traditional Screw Specifications No Longer Apply," Feb., 1937, p. 36.

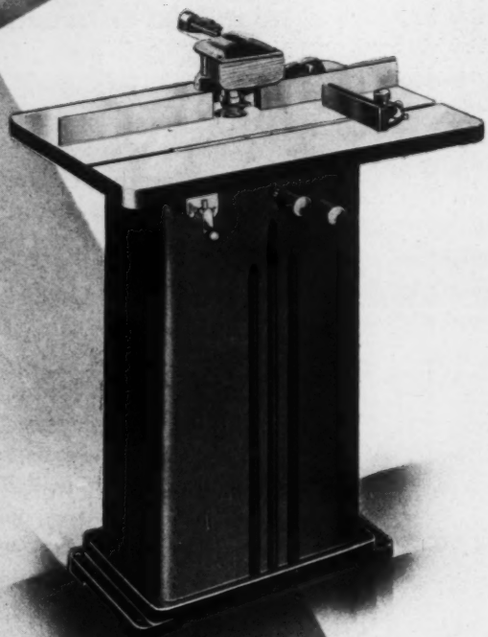
"It Pays to Consider the Unusual in Fastenings," by Guy Hubbard, December, 1937, p. 47.

"How Would Upset Parts Fit Your Picture?", by Guy Hubbard, Jan., 1938, p. 43.

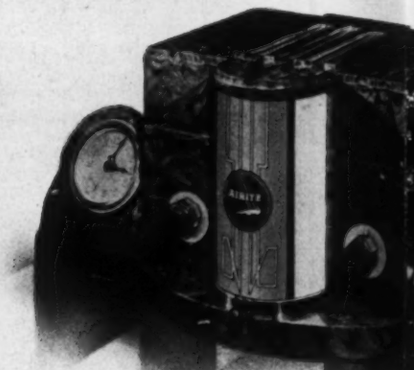
Design Features In New

A Pictorial Presentation of Recent Machinery from the Standpoint

ıbber is used for cleats of armon-Herrington track laying actor, allowing it to be operated ı any kind of highway. Water-ght, welded steel body of the actor permits it to ford streams of onsiderable depth. Machine has ıp speed of almost 40 miles per hour

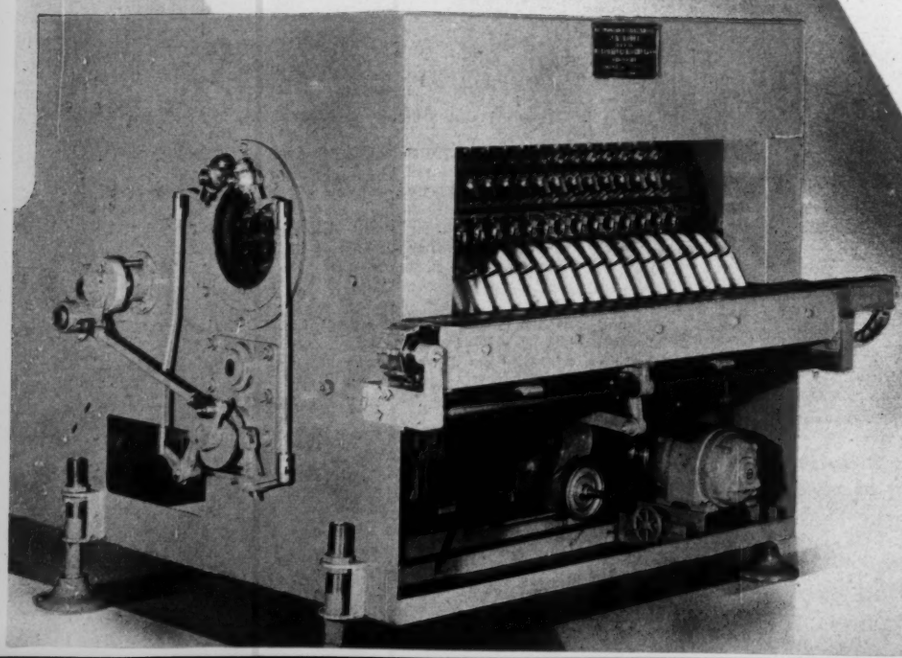


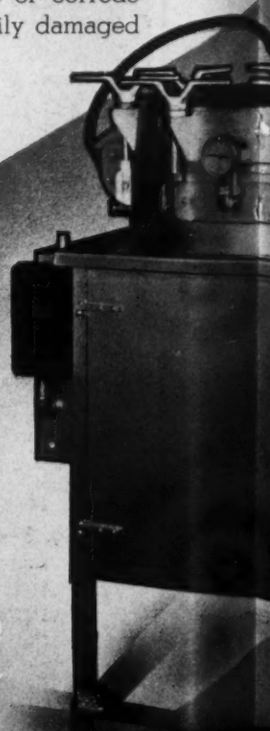
ivoted motor bracket and quick-ocking setscrew maintains proper ension of the two driving V-belts ı the Boice-Crane spindle haping machine, right. Blower ın is provided to draw chips way from work. Controls are onveniently placed for operator



Molded phenolic plastic is used for the case of this Sengbusch combination radio, ink stand and clock desk set. Unit is available in black or walnut Bakelite or ivory Plaskon. The case will not warp or corrode and cannot be easily damaged

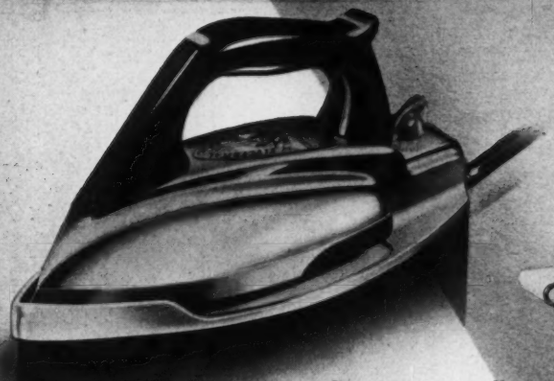
pecial turbine type pump dis-harges water at high velocity ıto bronze manifolds that have lternately placed spray nozzles ı the U. S. Bottlers automatic ottle washing machine, below. ariable speed drive is built ıto machine to regulate speed or different bottle sizes and shapes



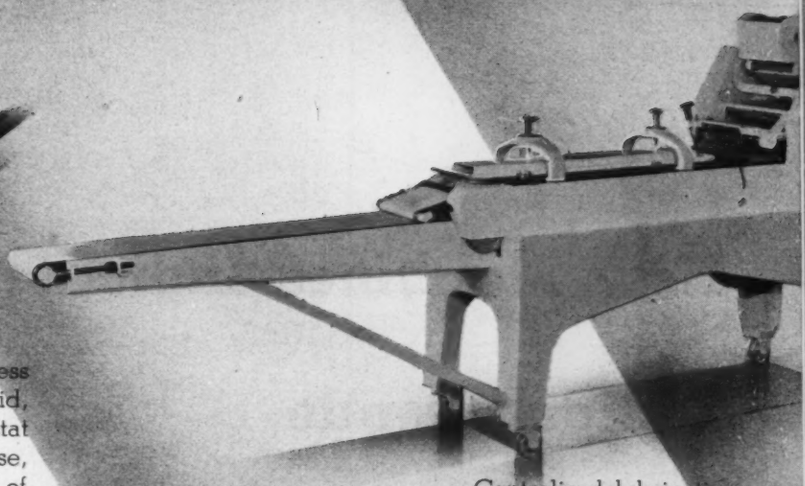


New Machines

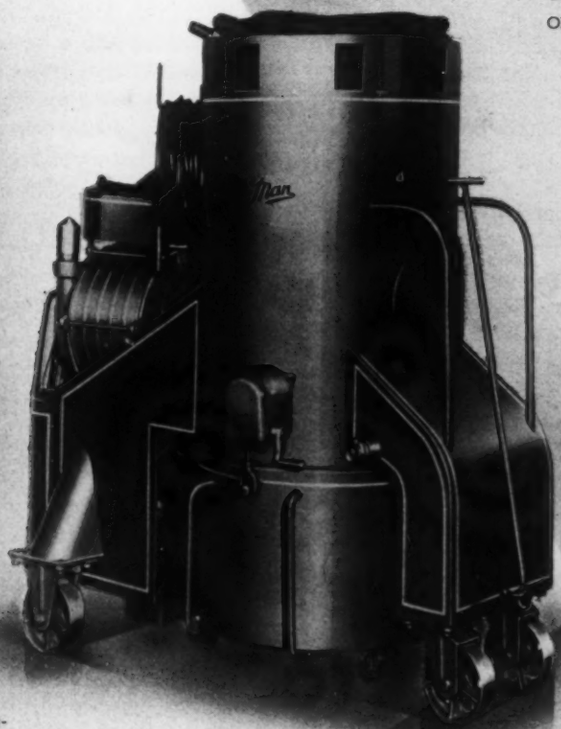
the Standpoint of Design



Base of the Chereton cordless electric iron is one piece, solid, die-cast aluminum. Thermostat for heat control of iron is in base, indicating exact temperature of ironing surface. Electrical contact is made while iron rests on its support, reheating quickly to proper temperature



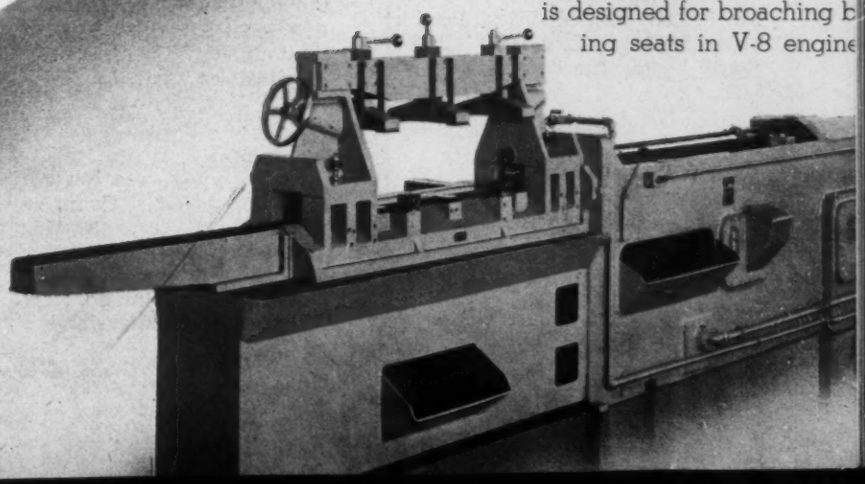
Centralized lubrication, corr resisting rolls and easy adjust for different bakery sizes are standing features of this B Perkins roll moulder and flatt Change from rolls or buns ca accomplished by merely low or raising curling and compre plates in the adjustment rar



Provision is made in the man portable vacuum clea unit, left, for carrying hose all other cleaning access as well as a saddle for co electric cord. Large collector, adequately se gives sufficient storage cap for lengthy operatior

Redesigned Hilco oil re-claimer, left, is totally en-closed and has thermostatic-ally controlled heaters for automatic operation. Single motor is used to drive vacuum pump and two small plunger pumps which handle dirty and clean oil

Cross head of Colonial bro ing machine, below, is ho casting which acts as oil re voir and has drilled pass leading to the shoes for lu cation of the ways. Vari speed control is provided hydraulic operation. Mac is designed for broaching b ing seats in V-8 engine



New Machines Indicate Design Trends

EXTREME maneuverability marks one of the recent advances in heavy machinery. Particularly is this trend apparent in the 1938 road machinery on exhibition last month at the Cleveland convention of the American Road Builders' Association. Scrapers and dump trucks were shown, so ponderous that their tires have an 18-inch cross section, yet capable of a variety of movements which include almost everything except twisting themselves upside down! One type of power-controlled grader, built with heavy seamless steel tubular frames, may readily be regulated from one position for a number of grading operations. It possesses leaning wheels, laterally shifting rear axle, steerable tongue and a grading blade that may be worked at almost any angle. In spite of this design which permits such maneuvering, heavy loads may be moved without strain or damage to the parts. Hydraulic pumps, cylinders and controls are responsible in many instances for the ease of operation of these formerly unwieldy types of machines. In addition to those on preceding pages, the following new machines have been developed.

Air Conditioning

Heating and cooling unit, Hexcel Radiator Co., Racine, Wisc.
Industrial heaters, General Electric Co., Schenectady, N. Y.
Coal and oil-fired unit, Fox Furnace Co., Elyria, O.
Unit heaters, Young Radiator Co., Racine, Wisc.
Electric ventilator, Emerson Electric Mfg. Co., St. Louis, Mo.
Burner-boiler, Anchor Post Fence Co,. Fluid Heat Div., Baltimore, Md.
Furnace blower, Lau Blower Co., Dayton, O.

Business

Cash registers, Ohmer Register Co., Dayton, O.
Duplicating machine, Ditto Inc., Chicago, Ill.

Domestic

Electric fans, Emerson Electric Mfg. Co., St. Louis, Mo.
Metal wardrobe unit, Berger Mfg. Div., Republic Steel Corp., Canton, O.
Duct heater, Bryant Heater Co., Cleveland, O.

Finishing

Disk sanders, Delta Mfg. Co., Milwaukee.
Polishing lathe, Crown Rheostat & Supply Co., Chicago.
Dust collector, American Air Filter Co., Inc., Louisville, Ky.
Blower for air helmets, The W. W. Sly Mfg. Co., Cleveland, O.
Sand blast gun, Michiana Products Corp., Michigan City, Ind.
Spray booth, The DeVilbiss Co., Toledo, O.

Foundry

Core wire straightener, Kane & Roach Inc., Syracuse, N. Y.
Furnace table, American Gas Furnace Co., Elizabeth, N. J.

Grinders

Roll grinder, Landis Tool Co., Waynesboro, Pa.
Universal grinder, Cincinnati Milling Mach. & Cincinnati Grinders Inc., Cincinnati.
Spindle grinder, Hammond Machinery Builders Inc., Kalamazoo, Mich.

Materials Handling

Crawler hoist, Harnischfeger Corp., Milwaukee.
Self-dumping hot-metal transfer car, Koppers Co., Bartlett Hayward Div., Pittsburgh.
Hydraulic lift truck, Lyon Iron Works, Greene, N. Y.
Portable elevator, Service Caster & Truck Co., Albion, Mich.

Mining

Two-roll spring-relief crusher, Link Belt Co., Chicago.
Air compressor, Schramm Inc., West Chester, Pa.
Jaw crusher, The Universal Crusher Co., Cedar Rapids, Ia.

Presses

Metal forming press, Farrel-Birmingham Co., Ansonia, Conn.
Inclinable power press, Thomas Machine Mfg. Co., Pittsburgh, Pa.
High speed press, Lake Erie Engineering Corp., Buffalo, N. Y.
Toggle press, Cleveland Punch & Shear Works Co., Cleveland, O.
Hydraulic press, Bucyrus-Erie Co., South Milwaukee, Wisc.

Printing

Stereotype machine, Reed-Prentice Corp., Worcester, Mass.
Developing machine, Ozalid Corp., New York.

Pumps

Water pump, Barrett Haentjens & Co., Hazleton, Pa.
Duplex steam pump, Fairbanks, Morse & Co., Chicago.
Centrifugal pump, The Deming Co., Salem, O.
Self-priming pump, Gorman Rupp Co., Mansfield, O.
Pumping unit, Worthington Pump & Machinery Corp., Harrison, N. J.

Welding

Electric welders, Hobart Bros., Troy, O.
Portable electric welder, General Electric Co., Schenectady, N. Y.
Portable welder, Giant Grip Mfg. Co., Oshkosh, Wisc.

Woodworking

Portable electric saw, Black & Decker Mfg. Co., Towson, Mr.
Electric hand saw, Porter-Cable Machine Co., Syracuse, N. Y.

Leasing Plan Holds Possibilities in Stabilizing Demand

FORTUNATELY for manufacturers of some types of machines there are certain ways, during a business recession as at present, of maintaining a comparatively brisk production schedule without building up unwieldy inventories. The system of leasing machines, for instance, instead of making outright sales is a case in point.

Where the need for a machine is felt only intermittently—in office, home or manufacturing plant—the leasing plan is obviously worth considering and has, in fact, been adopted already by many alert builders of machinery. But these are not the only outlets for leased equipment. Manufacturers of machines of certain types, particularly where they have been able to obtain a position of leadership in their respective fields, are leasing machines for practically permanent installation and are receiving, besides a minimum charge, a royalty on the basis of every unit produced by these machines.

It might be said that advances in design, if such a plan were adopted on a widespread scale, would be retarded. Such is not the case, however. It is only by constant research and development that the companies at present operating on this basis can remain in the forefront and create continuous demand. That their business fluctuates with general business conditions is inevitable—but that they are less beset by peaks and valleys in production and income than the average manufacturing concern is by no means less sure.

• • •

Watch the Diesel!

THERE is nothing revolutionary about the largest automobile manufacturer in the world setting up to produce diesel engines on a mass-production basis —but there *is* something impressive in the fact that these engines are to include a full range from large locomotive diesels down to comparatively tiny single-cylinder, two-stroke engines.

This undoubtedly heralds a new era in diesel design as well as in application of these engines in this country. And the time unquestionably is ripe for such developments. Observation at the recent Road Machinery show, for instance, disclosed that a large percentage of the new road building equipment utilizes diesel power—and that is only one of many fields of application.

The time may well come when the diesel will largely replace the gasoline engine, even for automobiles, leaving for gasoline units the lighter applications where weight per horsepower is the prime consideration. That is where the gasoline engine still scores and without doubt will remain in the lead for a long time to come.

Professional Viewpoints

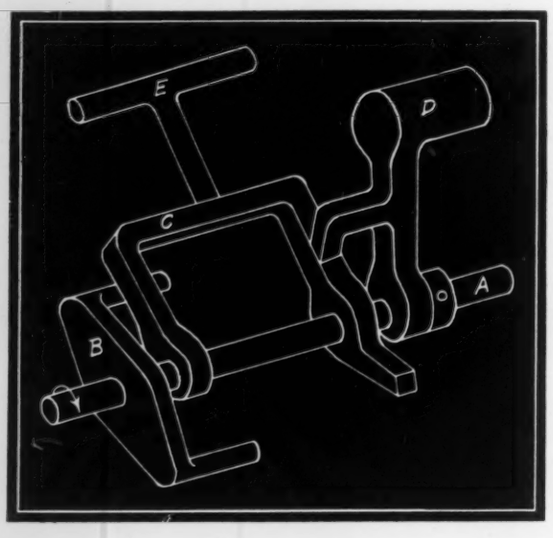
MACHINE DESIGN WELCOMES LETTERS SUITABLE FOR PUBLICATION

Marker Has Peculiar Operation

To the Editor:

DESIGN of a unique mechanism for placing a dye mark at regular intervals on a thread traveling at high speed is shown in the accompanying sketch. The thread is passing through a machine at approximately 40 yards per minute, and is to be marked every 500 yards.

The shaft *A* is driven in the direction indicated by a reducing chain drive connected with the feed rolls of the machine. The carrier *B* rotates with the shaft



A, the upper extension of *B* in contact with and turning the U-shaped member *C*, which turns free on shaft *A*. Likewise free on shaft *A* is the weighted lever *D* which receives its motion from member *C*. The T-shaped extension on the upper end of *C* is the marking piece, and dips into an ink reservoir in its lower position. Bearings not shown in the sketch support shaft *A* at each end; the entire assembly is supported on a receptacle containing the dye.

In operation, each complete revolution of part *C* results in the dye-coated marker *E* touching the threads once. As this must take place but once in the passage of 500 yards of thread, the shaft *A* must rotate slowly. However, as the thread must be marked at only one narrow spot, it is necessary for the marker *E* to travel at approximately the same speed as the thread when contact is made.

In the illustration, the weighted lever *D* is in a vertical position. As the weighted end of *D* passes the top center, it falls by gravity. The side extension of *D*, in its fall, strikes the extension on the lower end of *C*, which is then carried along with it. In this manner, *C* is given a partial rotation at a high rate of speed, and the dye mark placed on the threads by the marker *E* is little wider than the contact surface of *E*. After *E* marks the threads, it likewise falls.

Before the marker *E* has reached the dye, *C* makes contact with the lower extension of *B*, and is lowered slowly into the ink, not splashing it. The end of marker *E* remains immersed in the dye until the upper extension of *B* again reaches *C*, when the cycle is repeated.

—L. KASPER
Philadelphia

Reproduces "Inventions" Article

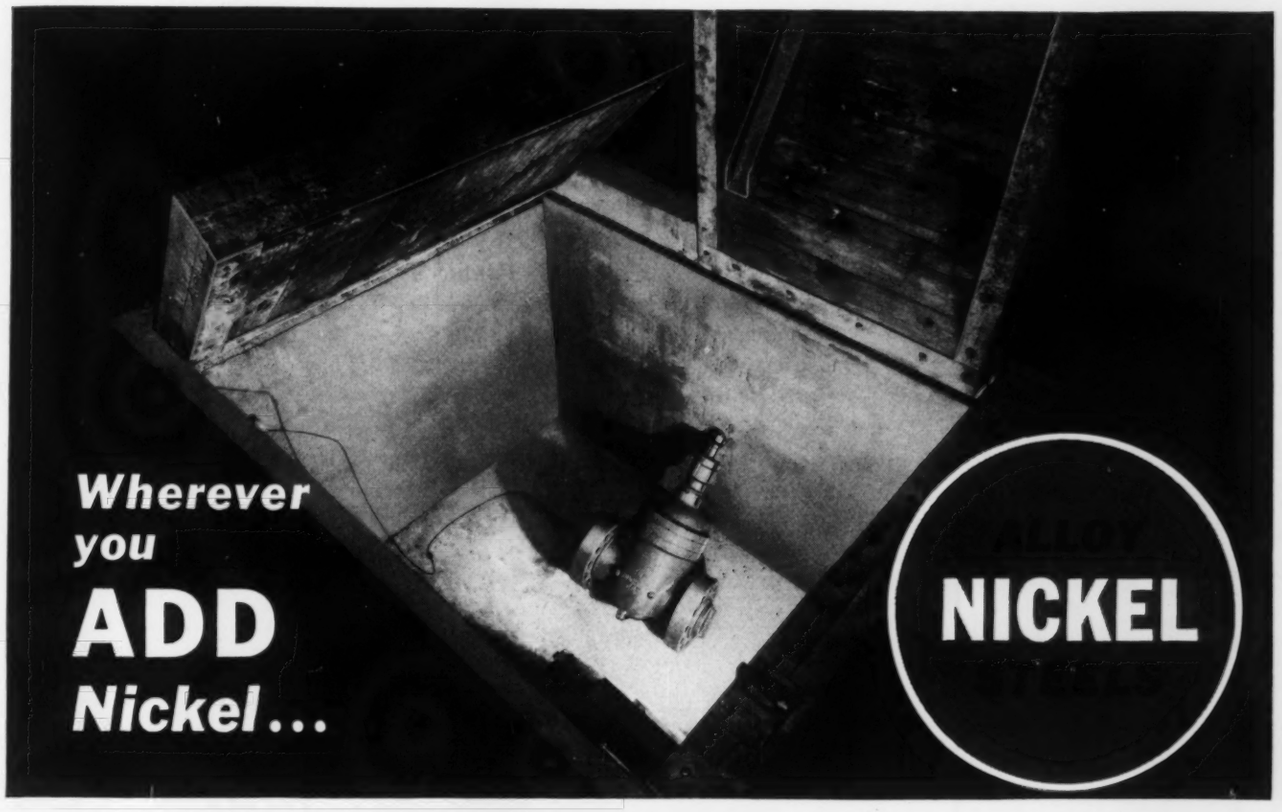
To the Editor:

As patent attorney for this company I am frequently called upon to answer questions of a general nature which are of interest, not only to those asking the question, but to everyone connected with the development of our products. I have found it advisable in some instances to rely upon the written explanation of experts who have spent considerable time on the particular subject, which brings me to the following.

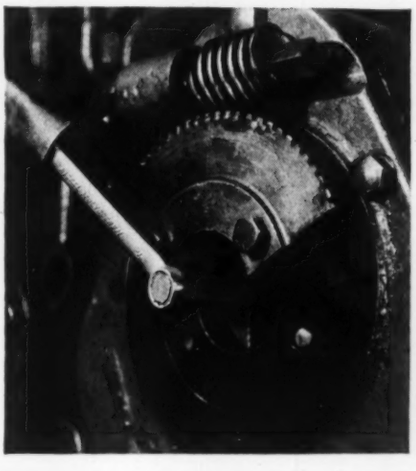
I have noticed the article "Replacement of Materials May Spell Invention", by George V. Woodling, author of "Inventions and Their Protection", published by your company, which article appears in the January issue of MACHINE DESIGN. Mimeographs of this article have been prepared for distribution to those interested within the company, but I wish to obtain your permission before doing so. I would also appreciate your assistance in obtaining Mr. Woodling's permission and wish to assure you that the mimeograph sheets will not be distributed unless I have both your and Mr. Woodling's consent.

—O. E. CHEATHAM
Airtemp Inc.

EDITOR'S NOTE: Permission of both MACHINE DESIGN and Mr. Woodling has been gladly given for reproduction of the article for the particular purpose mentioned.



...you quickly SUBTRACT from up-keep costs



Here is a story with a tinge of David and Goliath. A tiny wrench doing battle with a torsion machine to determine the load the former will bear before deformation. Note the steel rod which the wrench is gripping. When bolts were used instead of the rod, the heads were twisted off without the slightest effect on the wrench. Note also that this particular wrench is labeled "Nickel molybdenum" steel—the reason for its herculean strength.

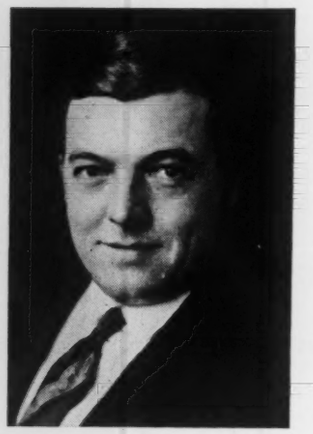
Resting in the concrete "destruction" pit pictured above is a high-pressure valve of cast Nickel alloy steel. This is where the Hughes Tool Company of Houston, Texas, tests the strength capacity of valves that are used in the petroleum industry. This firm made its first 10,000 p.s.i. valve over a year ago and the metal selected for the job was cast Nickel alloy steel. The high pressure 10,000 p.s.i. valve illustrated held up to 28,500 p.s.i., nearly three times its specified capacity, in this "destruction" test.

• • •

Topsy-turvy, this picture showing a man suspended from a highly magnetized pulley merely through the attraction of the nails in his shoes. Up-keep costs are usually revolutionized whenever Nickel alloy steel parts are used. High costs come down because Nickel imparts added strength and toughness—greater resistance to breakage and wear. In this case it's the Nickel steel shaft running through the magnetized pulley that acts as the watchdog of the treasury. Destined to go into magnetic separator equipment made by Dings of Milwaukee, this shaft had to be of small diameter, yet capable of carrying unusually heavy loads. Nickel steel won the job because of its superior strength—in this particular instance 200,000 p.s.i. Our engineers will be glad to consult with you and to point out the many ways in which the Nickel alloy steels will save you money.

THE INTERNATIONAL NICKEL COMPANY, INC., NEW YORK, N. Y.

Men of Machines



PHIL HUBER

ONE of the original incorporators of Ex-Cell-O Corp., in 1919, and secretary and director continuously since that time, Phil Huber was recently elected president and general manager. He became actively associated with the company in 1924, as chief inspector, and later became successively factory superintendent, and factory manager. In 1930 he accepted additional responsibility when the company began an expansion program acquiring other companies. His success is demonstrated by the rise of the company. In recent years he has been closely identified with research and development, manufacturing and refinement of products.

Mr. Huber's experience includes close association with machine tool building companies and many leading automobile companies. Previous to his Ex-Cell-O, he spent eight years with the Ford Motor Co.

J. M. FERNALD

RECOGNIZED as one of the leading executives in the refrigerating machinery and air conditioning industries in recent years, J. M. Fernald, general manager of Baker Ice Machine Co. Inc., Omaha, Nebr., has been elected president of the Refrigerating Machinery association.

After eighteen months' service in the Engineers Corps Mr. Fernald joined Cutler-Hammer Inc., first as sales manager and later district manager, gaining particular recognition for industrial research. He is credited by American Institute of Electrical Engineers with original work in application of automatic control in the textile industry and in application of electromagnetic clutches in the papermaking industry. At the beginning of the development and growth of mechanical refrigeration in 1926, Mr. Fernald went with Electric Refrigeration Corp. (now Kelvinator).

• • •

S. C. HOLLISTER

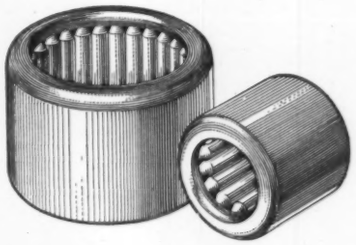
PROF. S. C. HOLLISTER, recently named dean of the college of engineering, Cornell university, is an engineer with a record of significant achievement in engineering practice and education. Since 1934 he has been director of the school of civil engineering, and for a year was associate dean of the college. At the death of Dean Herman Diederichs he became acting dean.

Graduating in 1916 with a B. S. in C. E. degree from the University of Wisconsin, he later taught for a year at the University of Illinois. For two years he served with the U. S. Shipping Board, and then spent ten years in private practice before returning to academic life as professor at Purdue in 1930.

According to Arthur R. Lord, consulting engineer of Chicago, "The

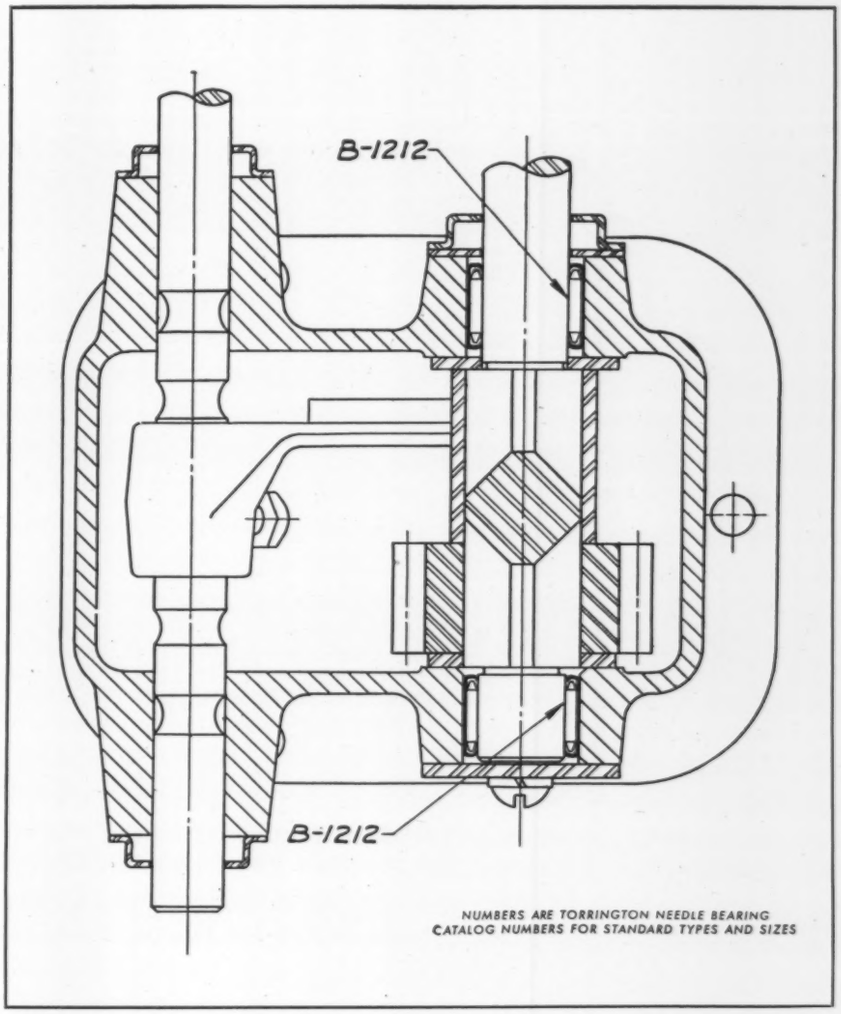
TORRINGTON NEEDLE BEARING

DESIGN AND SERVICE FEATURES



HIGH LOAD CAPACITY SIMPLIFIES DESIGN

In This Power Take-Off Unit . . . A Typical Application



High radial load capacity of the new Torrington Needle Bearing is one of the features which make it ideally suitable for unusually severe applications, such as the one illustrated here.

In power take-off units the loads may be exceptionally high. In such applications the many lineal inches of contact provided by this new Needle Bearing's full complement of small-diameter rollers give it an extremely high radial load capacity for its size.

Likewise, size and shape of this new anti-friction bearing are important in maintaining accurate alignment of shafts without introducing complexities in the design of the equipment. Because the bearing is comparatively long axially and small radially, the simplest type of housing bore, machined to proper dimensions, is all that is required. The shaft must, of course, be hardened sufficiently to take the maximum load, and in cases of unusually high loads the use of specially hardened Needle Bearings is recommended. Ease of lubrication, as the turned-in lip of the bearing retains a large amount of grease or oil, is another important advantage in heavy-duty applications.

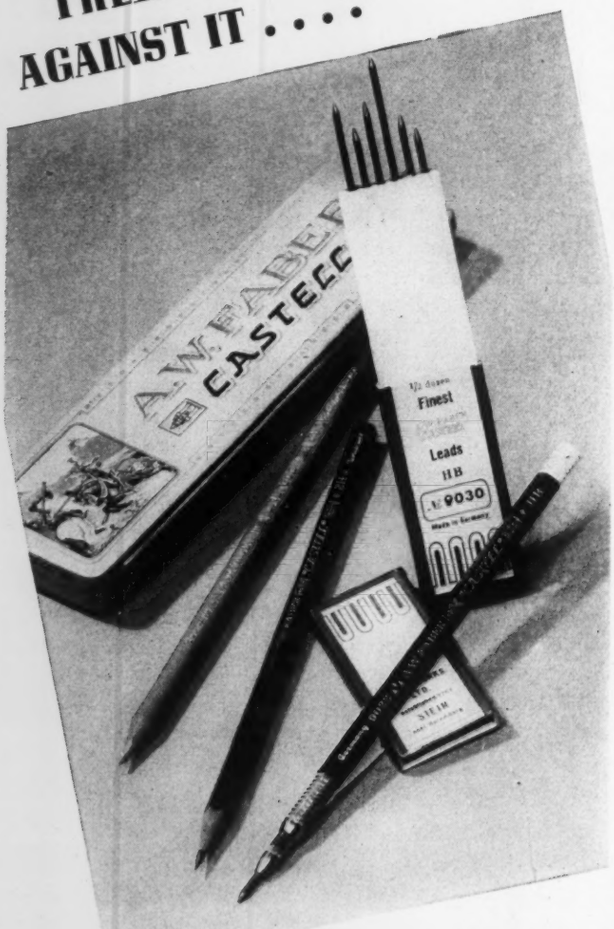
Manufacturers desiring expert advice on the specialized subject of bearing design and layout are invited to avail themselves of the broad experience of the Torrington Engineering Department.

Further information is given in the Torrington Needle Bearing Catalog, available on request. Write for Catalog No. 9.

The Torrington Company
ESTABLISHED 1866
Torrington, Conn., U.S.A.
Makers of Ball and Needle Bearings
Branch Offices in all Principal Cities

TORRINGTON
NEEDLE BEARING

THERE'S NO Law AGAINST IT . . . .



BUT it does seem unusual to walk into a large drafting room and not find at least one of these famous A. W. Faber products:

No. 9000 "Castell" Drawing Pencil, world's standard of quality, milled by patented microlette process to achieve super-smooth tone uniformity.

No. 9022 Artists' Refill Pencil with patented knurled grip.

No. 9030 leads for same, 16 degrees, same quality as in the wood pencil.

No. 9201 "Castell" Polychromos Pencils, the nearest approach to actual oil paintings. 65 colors.

A·W·FABER·Inc. NEWARK, N. J.

most disconcerting thing about S. C. Hollister is his youth . . . . he brings to his new responsibilities not only youth in the mere matter of years, but corollary attributes—the animation and spirit of youth and a warm and contagious interest in a wide range of subjects of great diversity . . . His activity will never be confined to the campus, for Holly is a salesman ever—with the higher salesmanship of ideas which is the gift of a colorful, spritely, omnivorous mind, looking at old concepts and practices in new and illuminating ways."

♦ ♦ ♦

E. H. LESLIE has joined the technical staff of the Blaw-Knox Co., Pittsburgh. In his new capacity Dr. Leslie, authority on the chemical process industries, will be in charge of design and fabrication of operating units for the chemical and oil refining industries. He is best known to the industrial world for his work as consulting engineer and for his operation, since 1923, of the Leslie Laboratories, Ann Arbor, Mich.

♦ ♦ ♦

D. P. BARNUM has been reelected president of the the American Standards association.

♦ ♦ ♦

H. H. LEONARD, vice president of the Consolidated Packaging Machinery Corp., continues as president of the Packaging Machinery Manufacturers' institute.

♦ ♦ ♦

CHARLES J. MCCARTHY, engineering manager of Chance Vought Aircraft division, East Hartford, Conn., has been named assistant general manager.

♦ ♦ ♦

GERHARD ANSEL has joined the metallurgical staff of Dow Chemical Co., Midland, Mich. He was previously connected with the Metals Research Laboratory of Carnegie Institute of Technology.

♦ ♦ ♦

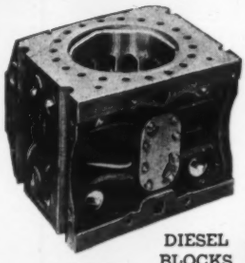
D. T. DOWNES, chief engineer, Calorizing Co., has resigned to accept a position as development engineer for Pittsburgh Plate Glass Co. at the recently organized central development laboratory.

♦ ♦ ♦

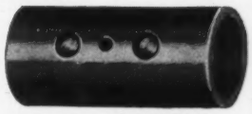
E. P. BULLARD, president of Bullard Co., received the American Society of Mechanical Engineers' medal "for outstanding leadership in the development of station-type machine tools". This development includes designing of machines for the automotive and similar industries.

♦ ♦ ♦

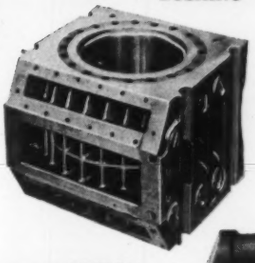
WALTER L. UPSON has been appointed head of the research department, Torrington Mfg. Co. He formerly was professor of electrical engineering at Washington university, St. Louis, and has been a consulting engineer for the Torrington company for several years. Specializing in fans and air impellers, Prof. Upson in-



DIESEL BLOCKS



BUSHING



VALVE LINER

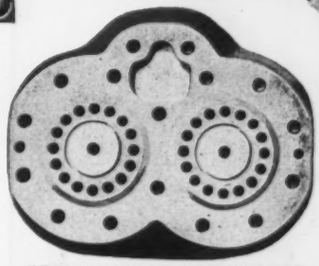
HOOK
TO DIP REELS OF WIRE INTO MOLTEN BATH

STOKER LINK

DIESEL PISTON

CRANKSHAFTS

BUBBLE CAP
OIL STILL



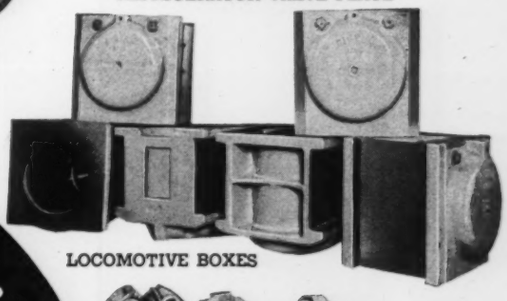
REFRIGERATOR VALVE PLATE

VALVES

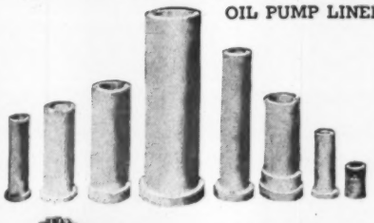
TAPPETS

CAMSHAFT

OIL PUMP LINERS

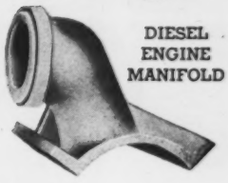


LOCOMOTIVE BOXES

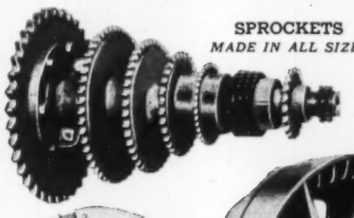


SPROCKETS
MADE IN ALL SIZES

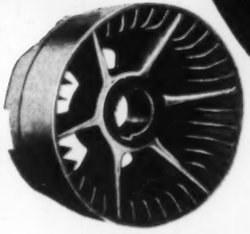
AIRPLANE CYLINDERS



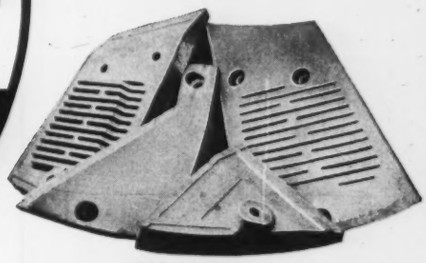
DIESEL ENGINE MANIFOLD



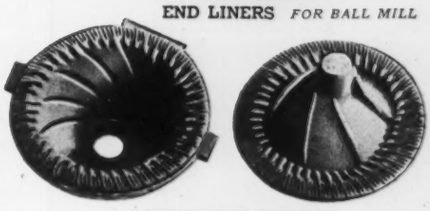
TOOL STEEL INDEXING PLATES
NOW MADE ONE-PIECE MEEHANITE CASTING



COMBINATION CLUTCH & BRAKE
GIVING SUPERIOR SERVICE IN MEEHANITE



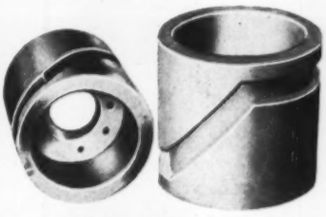
END LINERS *FOR BALL MILL*



COFFEE MILL BURRS

COG CYLINDER

COKE PRICKER RINGS
FLAME HARDENED



BARREL FEED CAMS
FOR AUTOMATIC DRILLING MACHINES FORMERLY TOOL STEEL

HARDENED CAM

SCALE LEVER

ASH PUMP

CRANE BRAKE DRUM

DEPENDABLE · FREE MACHINING · STRONG · TOUGH · MEEHANITE CASTINGS · SOUND · DENSE · TRUE TO PATTERN · UNIFORM ·

MEEHANITE IS PARTICULARLY ADAPTED TO SMALL AND MEDIUM WEIGHT CASTINGS WHERE ACCURATE DIMENSIONS AND CORING MUST BE OBTAINED, AND WHERE A CLOSE-GRAINED UNIFORM METAL IS NECESSARY.

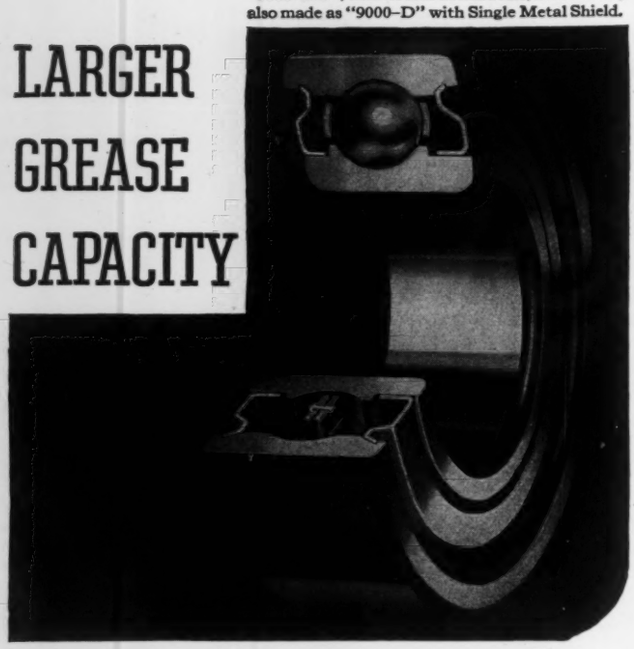
MANUFACTURERS:

American Laundry Machinery Co. ..... Rochester, N. Y.
Atlas Foundry Co. ..... Detroit, Mich.
Banner Iron Works ..... St. Louis, Mo.
H. W. Butterworth & Sons Co. ..... Bethayres, Pa.
Cincinnati Grinders Incorporated .... Cincinnati, Ohio
The Cincinnati Milling Machine Co. .. Cincinnati, Ohio
Cooper-Bessemer Corporation ..... Mt. Vernon, Ohio
Crawford & Doherty Foundry Co. .... Portland, Oregon
M. H. Detrick Co. ..... Peoria, Ill., Newark, N. J.
Farrel Birmingham Co. ..... Ansonia, Conn.
Florence Pipe Foundry & Machine Co.
(R. D. Wood Company, Philadelphia, Selling Agents)

METAL
Registered Trade Mark

Fulton Foundry & Machine Co. ..... Cleveland, Ohio
General Foundry & Mfg. Company ..... Flint, Mich.
General Iron Works ..... Denver, Colo.
Greenlee Foundry Company ..... Chicago, Ill.
Hamilton Foundry & Machine Co. ..... Hamilton, Ohio
Kanawha Manufacturing Co. ..... Charleston, West Va.
Kinney Iron Works ..... Los Angeles, Calif.
Koehring Company ..... Milwaukee, Wis.
Rosedale Foundry & Machine Co. ..... Pittsburgh, Pa.
Ross-Meehan Foundries ..... Chattanooga, Tenn.
Vulcan Foundry Company ..... Oakland, Calif.
Warren Foundry & Pipe Corp. ..... Phillipsburg, N. J.
Washington Iron Works ..... Seattle, Washington

"9000-DD", with double Metal Seals, here shown; also made as "9000-D" with Single Metal Shield.



LARGER GREASE CAPACITY

NO SEAL DRAG

IN "9000" SERIES (Feltless)

SELF-SEALED BEARINGS

Interchangeable in dimensions with felt seal bearings.

Employs simplified, inwardly extending, flanged metal shields which do not rotate and cannot "foul" other rotating seal parts.

Seals are highly efficient in retaining grease in either horizontal or vertical position.

Simple seal occupies less space within bearing than felt seal, PROVIDING GREATER GREASE CAPACITY AND A MORE LASTING LUBRICANT SUPPLY.

Metal seals, though close fitting, clear recess on inner ring, ELIMINATING "DRAG" OR FRICTIONAL RESISTANCE and power loss, and providing higher starting speeds and increased efficiency. Seals cannot wear and are permanently effective.

Totally sealed against foreign matter, providing absolute cleanliness at all times.

"NORMA-HOFFMANN"

PRECISION BEARINGS

BALL, ROLLER AND THRUST

NORMA-HOFFMANN BEARINGS CORP'N.

STAMFORD, CONNECTICUT, U. S. A.

vented the "Airistocrat" fan now being made by the Torrington company.

♦ ♦ ♦

H. M. WHITTAKER, formerly chief engineer of the the Micromatic Hone Corp., has been made vice president and director of sales. This appointment is part of the expansion of the executive personnel of the Micromatic company since the purchase of Hutto Machine division of Carborundum Co. jointly with Barnes Drill Co. J. E. KLINE, formerly chief engineer of the Hutto division becomes chief engineer in the combined organization.

♦ ♦ ♦

DR. SANFORD A. MOSS has retired after 34 years of service with the General Electric Co. Before retirement he was mechanical engineer at the company's Thomson research laboratory, West Lynn, Mass., and was prominent in the development of the centrifugal compressor and supercharger for aviation engines. Dr. Moss has been awarded some 36 or more patents on mechanical devices.

♦ ♦ ♦

C. W. SPICER, vice president, of Spicer Mfg. Co., Toledo, O., was chosen president of the Society of Automotive Engineers at its recent annual convention.

♦ ♦ ♦

JOHN C. SHARP has been appointed chief engineer of Edison General Electric Appliance Co. Inc., succeeding the late CHARLES P. RANDOLPH.

♦ ♦ ♦

DR. G. M. L. SOMMERMAN of the physical laboratory staff of the American Steel & Wire Co., Worcester, Mass., was the recipient of the Alfred Noble prize for the best technical paper published by any member under 30 years of age of either the ASCE, the ASME, the AIEE or the AIMME. The award was made for a paper, "Properties of Saturants for Paper-Insulated Cables," presented before the AIEE.

♦ ♦ ♦

C. D. MEALS has been appointed chief engineer of the Wire Rope division, Bethlehem Steel Corp., Williamsport, Pa.

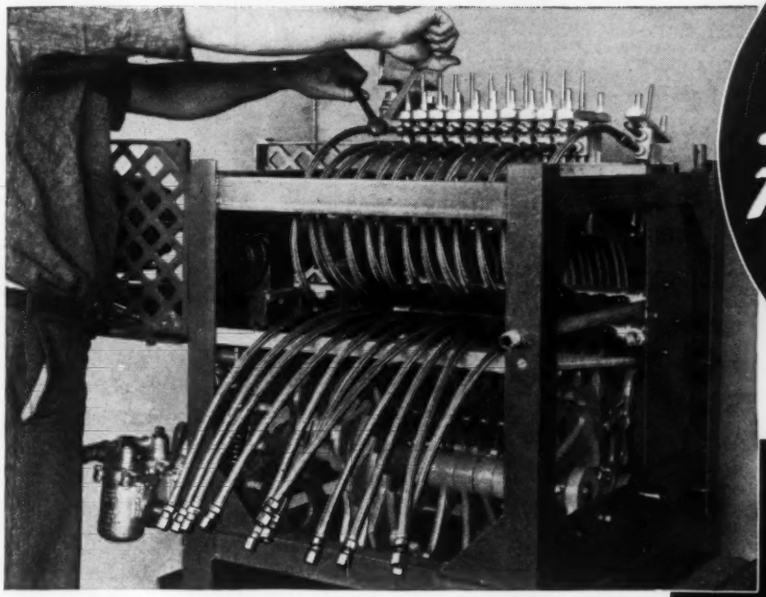
♦ ♦ ♦

A. P. LIVAR was recently made chief engineer in charge of heating design for Airtemp Inc., air conditioning subsidiary of Chrysler Corp.

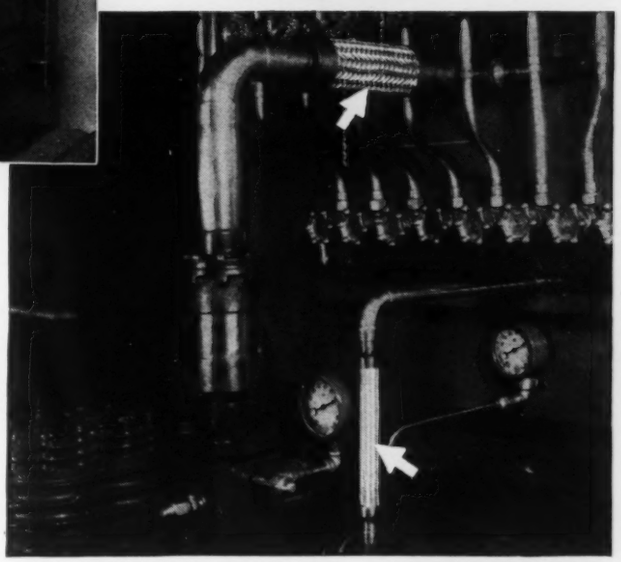
♦ ♦ ♦

HOWARD A. FLOGAUS, formerly with Yellow Truck & Coach Mfg. Corp., Pontiac, Mich., has been named chief engineer for Reo Motor Car Co., Lansing, Mich., succeeding G. WAINE THOMAS, resigned. Mr. Thomas, formerly chief engineer of Reo Motor Car Co., with which he was associated for ten years has joined the Mack Mfg. Co., Allentown, Pa., in an engineering capacity.

American Flexible Hose means Permanent Service



American Seamless Flexible Metal Tubing gives steady service in conveying steam to hosiery molds while flexing back and forth continuously.



American Flexible Vibration Eliminators are used to form a break in the refrigerant lines on air conditioning and refrigerating machinery, or in any rigid pipe line that is subject to the devastating effect of vibration.

AGAINST the twin menaces of vibration and seepage, American Metal Hose and Tubing offers industry a potent weapon. Wherever a flexible connector or conductor is needed to take up movement of parts, or where vibration threatens to crack rigid pipe, "American" has a seamless, all-metal flexible tubing to fill the bill. For carrying air, oil, water, steam, or fuels of various kinds, "American" has 30 years of successful experience to recommend it. Past tests have proven that it is the hose for present *and future* service.

Illustrated are but 2 of the countless applications of this sturdy, seep-proof tubing. The machine tool builder, the air conditioning manufacturer, the locomotive designer, the air craft maker — these and many other vital industries fully realize the value of properly designed, leakproof connectors as original parts on their products. In maintenance work, too, American Metal Hose scores heavily, preventing shut downs and cutting costs. 38312

• • •

ANACONDA
from mine to consumer

Write us in detail about your problem. Our Engineering Service will extend the fullest cooperation without cost.

THE AMERICAN BRASS COMPANY

American Metal Hose Branch

General Offices: WATERBURY, CONNECTICUT

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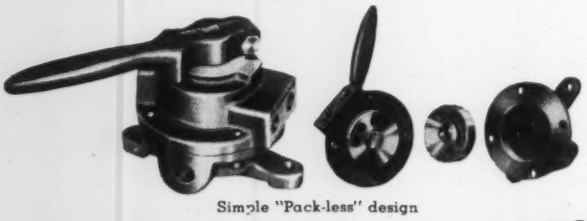

Simple "Pack-less" design

Hand Control Valves

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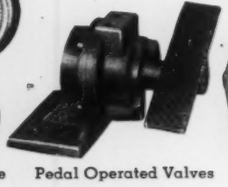

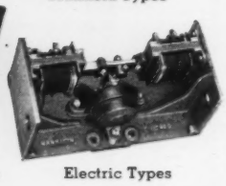

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Noteworthy Patents

PATENT No. 2,096,002, granted to Salvador Moreira and Ernest Sabol of Worcester, Mass., assignors to the American Steel & Wire Co., makes use of the power of a modified fire-arm to drive stud terminal bonds firmly into holes near the ends of railroad rails.

This device, which is shown in working position in *Fig.* 1, has a cylinder which corresponds to the barrel of an ordinary gun. In this cylinder is a piston which normally is kept pushed back by a coil spring. The impacting tool which strikes the stud being set

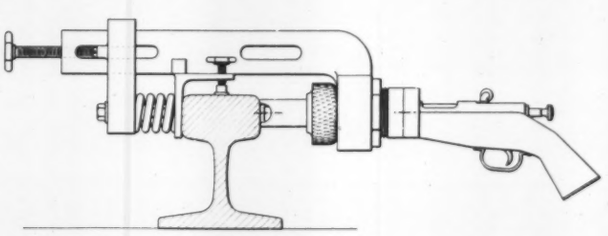

Fig. 1—*This tool harnesses "gun power" to drive stud terminals firmly into holes in steel rails*

is mounted on an extension of this piston which corresponds to a piston rod.

The single shot gun unit, which handles blank cartridges, is connected to the cylinder so as to discharge directly into it, thus driving forward the piston and setting the stud when the trigger is pulled. As will be noted from the diagram, the clamp by which the device is held to the rail in working position embodies a heavy spring shock absorber to take up the recoil when the gun is fired.

Unique Transmission

A JOINT invention by Earl C. Russell and Lester A. Cosens of Portland, Ore., shown diagrammatically in *Fig.* 2, has for its purpose the transmission of power between a driving and a driven shaft with the possibility of effecting a predetermined change in the rate of rotation while keeping the shafts on a common center line. Patent No. 2,090,810 has been granted on this invention.

The device consists of a driving and a driven shaft journaled into an oil tight, free, cylindrical casing

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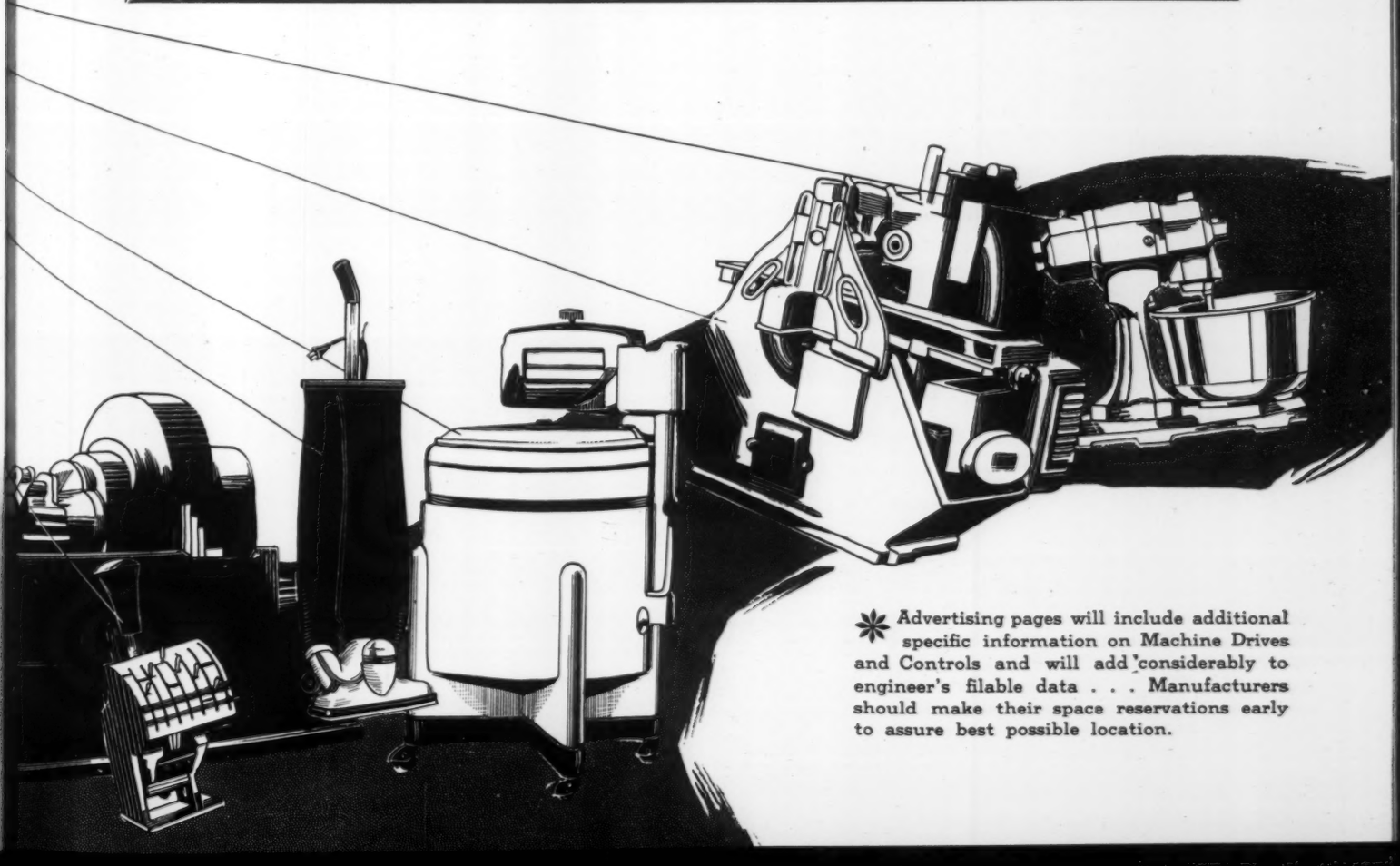
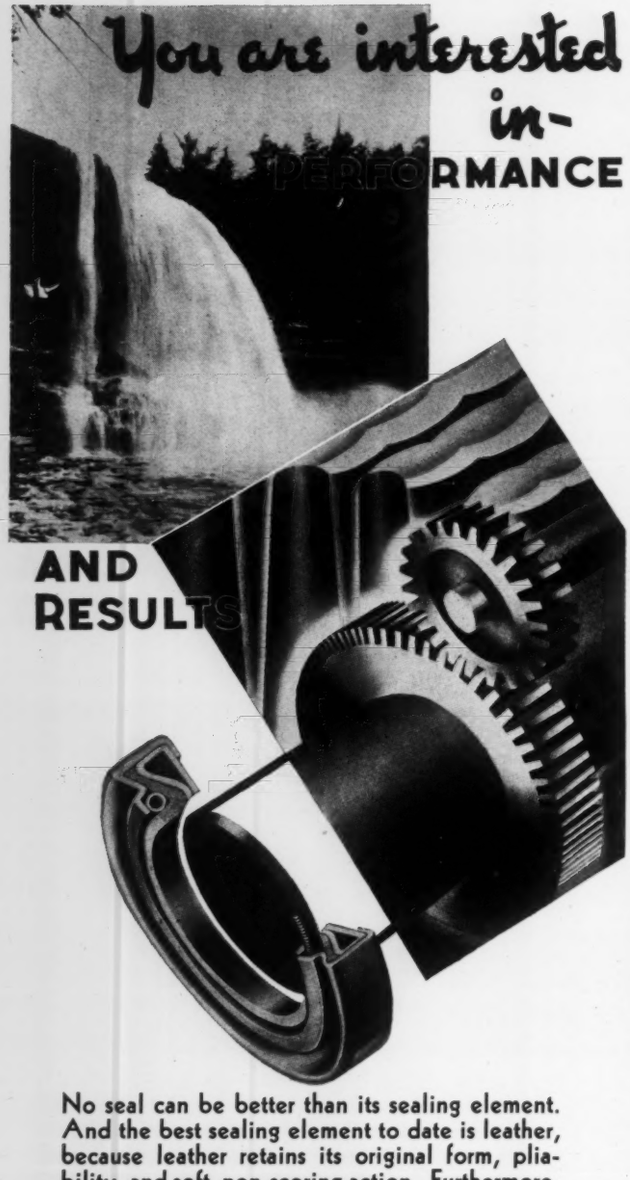


* Advertising pages will include additional specific information on Machine Drives and Controls and will add considerably to engineer's filable data . . . Manufacturers should make their space reservations early to assure best possible location.



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containing gears and linkage. The driving shaft enters through the removable head of the casing and passes through the hub of a bevel gear bolted to the underside of this head. Fixed to the lower end of this input shaft is a spider carrying at one side a second bevel gear which may be of a different diameter. This one is free to revolve on a horizontal axis and meshes with the fixed gear. On the opposite side of the spider there is a weight to counterbalance the assembly.

A stub shaft fixed in the hub of the second bevel gear is connected through a linkage, consisting of two universal joints and a short intermediate shaft, to another stub shaft running in a counterbalanced arm fixed to the inside end of the output shaft at the bottom of the casing. On this lower stub shaft is fixed a spur gear which meshes with another spur gear anchored firmly to the bottom of the case. The output shaft passes through a bearing in the hub of this fixed gear, thence out through the bottom of the casing.

When the input shaft revolves, it carries the spider around with it. This rolls the horizontal bevel gear

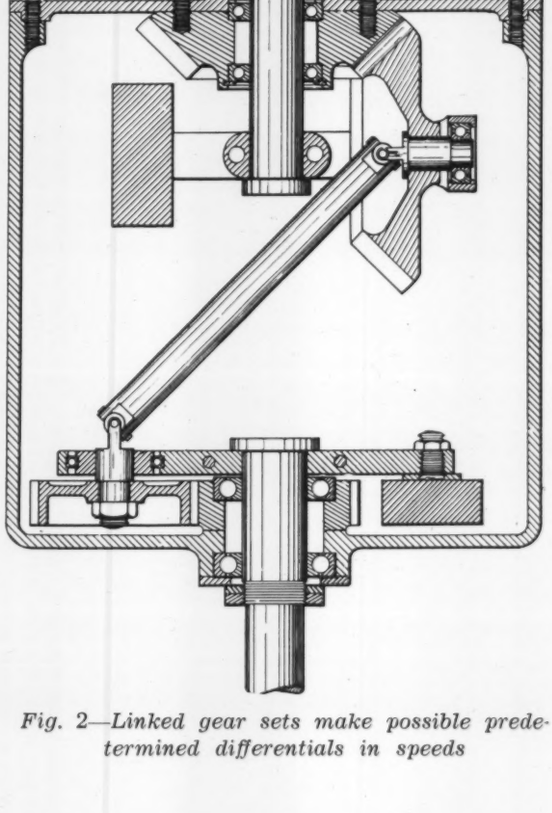

Fig. 2—Linked gear sets make possible predetermined differentials in speeds

around on the fixed bevel gear, the rotational speed of the horizontal gear depending upon the ratio between the two. This compound action revolves the linkage around its own centers and at the same time sweeps the whole assembly around the common cen-

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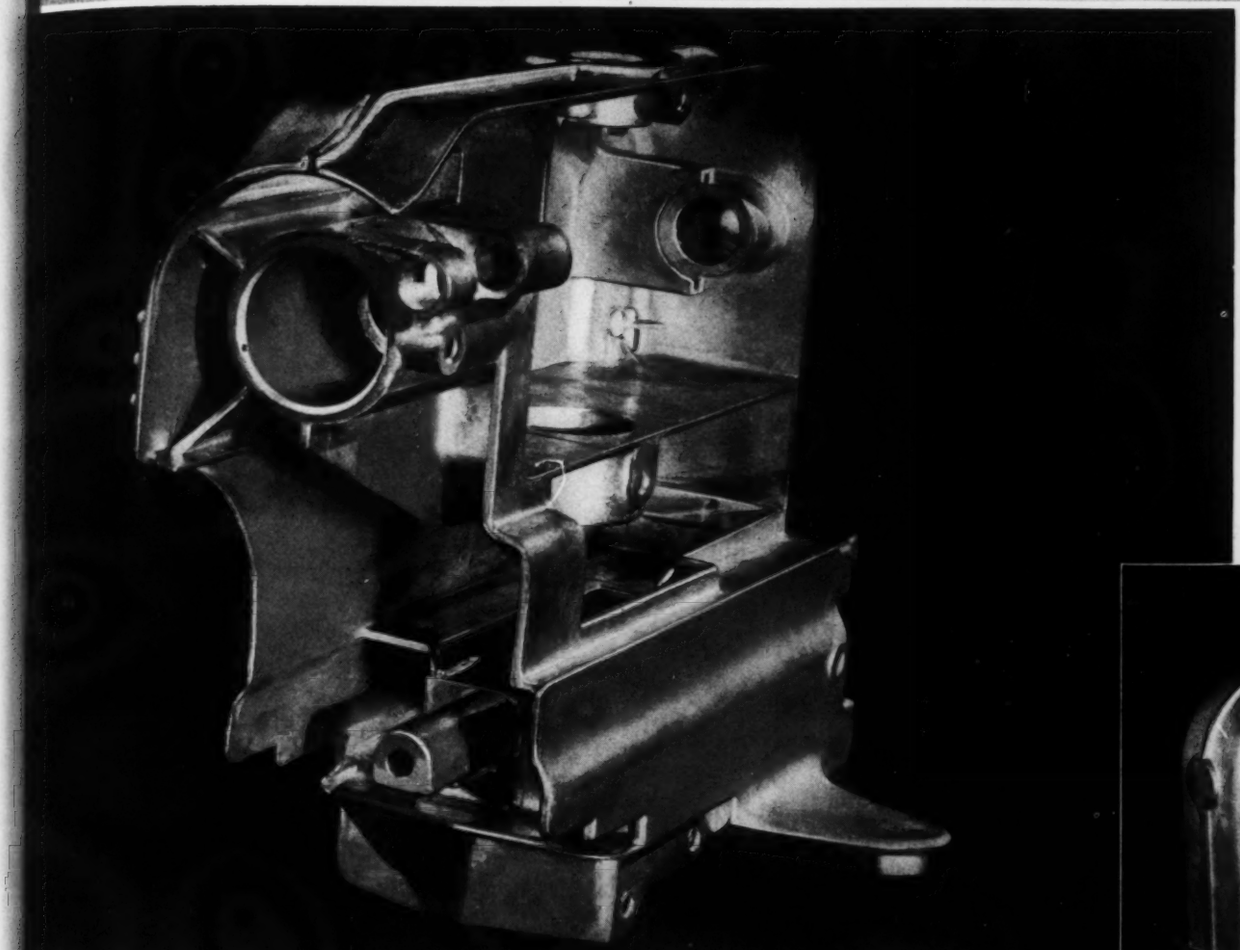

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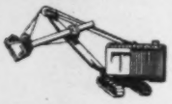

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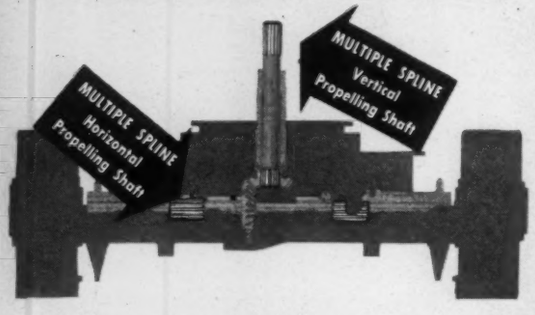

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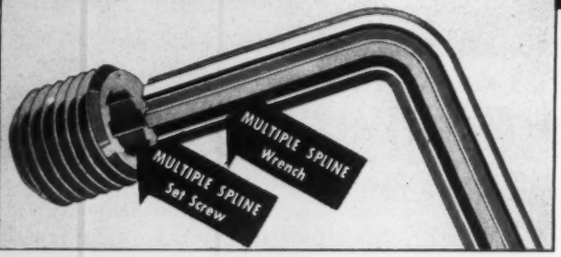

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Multiple Spline

SET AND CAP SCREWS

(*Continued from Page* 66)

ter line of the input and output shafts.

The linkage in turn revolves the spur gear on the arm at the bottom of the case, causing it to roll around the fixed spur gear and thereby revolving the output shaft.

Breaks Centrifugal Sail Cycle

TANDY A. BRYSON of Troy, N. Y., has patented and assigned to American Machine & Metals, Inc. of New York City, what he describes as ". . . a means for eliminating gyroscopic 'sail' or precession in a centrifugal separator, without creating undue resistance to 'whip' oscillation". The main features of this new type of bearing mounting, covered by Patent No. 2,094,058, are shown in *Fig.* 3.

Supported in the base of the machine by means of a ball and socket joint is a relatively short non-revolving shaft. This normally is kept in a vertical position by two matched radial compression springs which press against a spring retaining member on the lower end (short arm) of this shaft.

The rather widely spaced anti-friction bearings run on a non-revolving sleeve on the long arm of this shaft, above the ball and socket joint, surrounding which is the rotating sleeve upon which the centrifugal basket is rigidly supported. The effect of the spring resistance to swing in one meridian plane only is said ". . . to break up entirely the tendency to 'sail' at any frequency whatever, since inertia of the loaded basket is too great to be accelerated or decelerated quickly within the period of a single sail cycle".

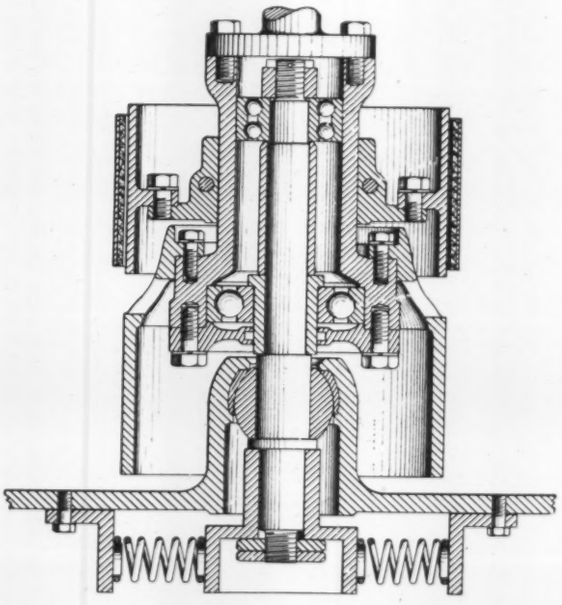

Fig. 3—*Ball and socket support with springs acting in one plane only is centrifugal innovation*

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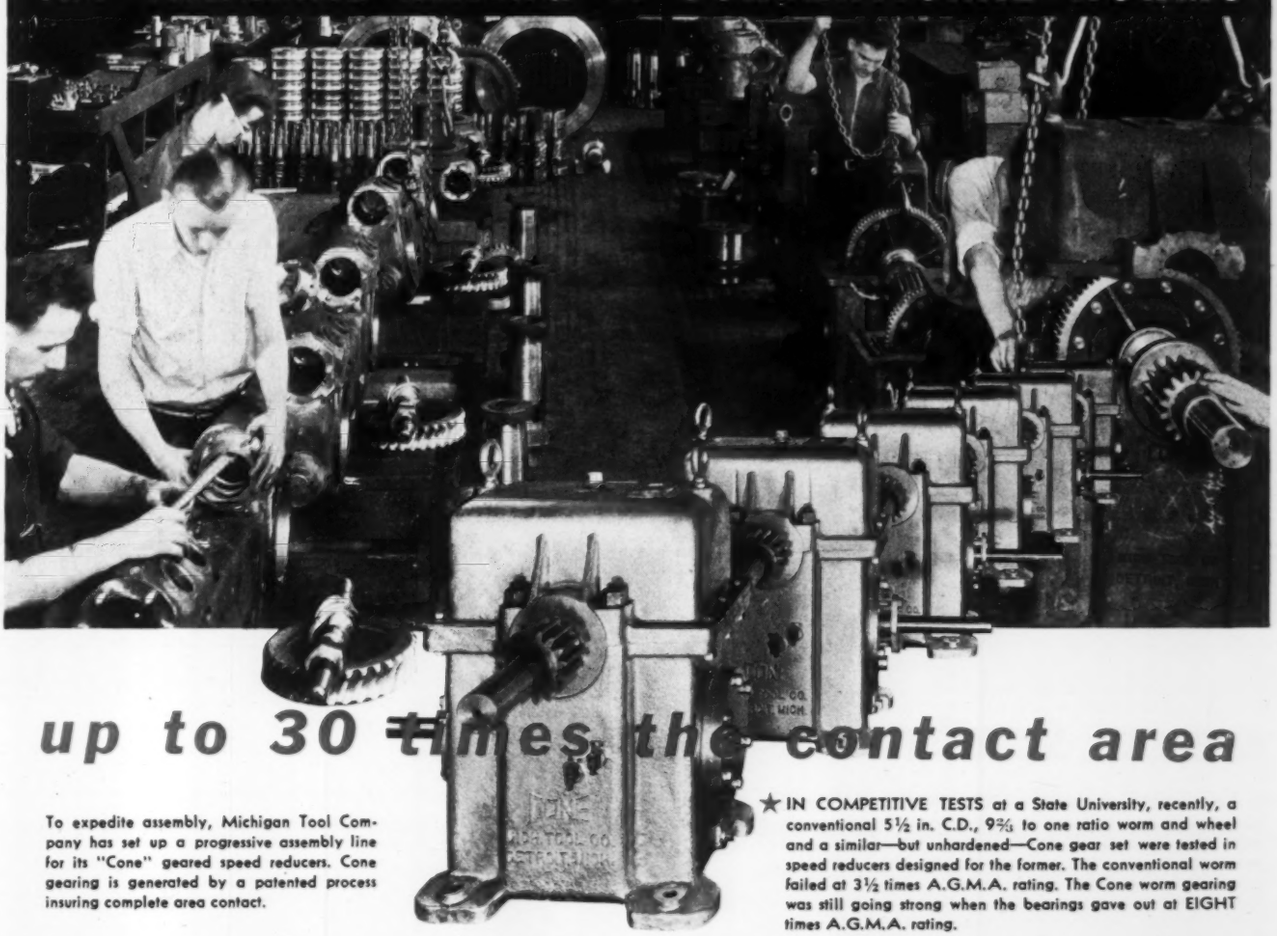

up to 30 times the contact area

To expedite assembly, Michigan Tool Company has set up a progressive assembly line for its "Cone" geared speed reducers. Cone gearing is generated by a patented process insuring complete area contact.

★ IN COMPETITIVE TESTS at a State University, recently, a conventional 5½ in. C.D., 9⅔ to one ratio worm and wheel and a similar—but unhardened—Cone gear set were tested in speed reducers designed for the former. The conventional worm failed at 3½ times A.G.M.A. rating. The Cone worm gearing was still going strong when the bearings gave out at EIGHT times A.G.M.A. rating.

For a given power-transmission requirement this means that smaller speed reducers can be used to do the same job. Identical sizes of CONE-geared speed reducers, similarly, will handle many times the power possible with conventional worms.

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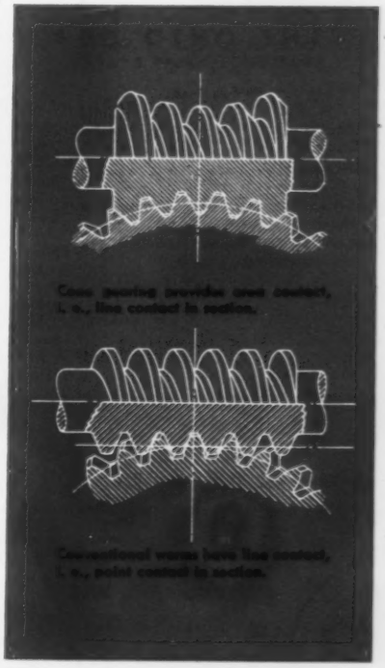
Cone gearing provides area contact, i. e., line contact in section.
Conventional worms have line contact, i. e., point contact in section.

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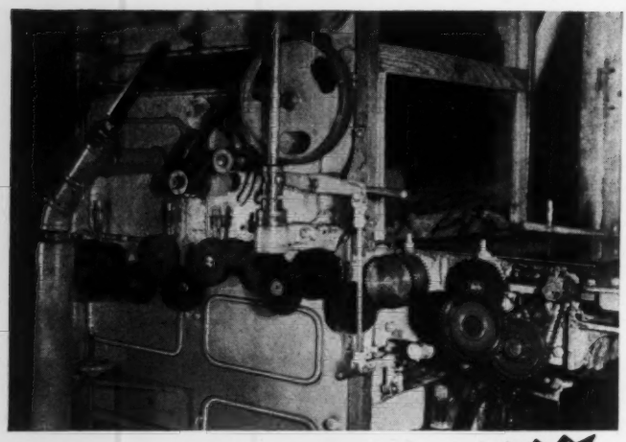

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*Stocks carried.

OHIO GEARS

Helical Spring Design

(*Continued from Page* 41)

maximum working stress from equation (15) is then:

$$s_{max}=C_w\ s'_e/N=1.53\times 60{,}000/1.5=61{,}000 \text{ pounds per square inch.}$$

If the spring index c were 10 instead of 3, the factor C_w (*Fig.* 10) would be 1.39 and the permissible stress would be:

$$s_{max}=C_w\ s'_e/N=1.39\times 60{,}000/1.5=56{,}000 \text{ pounds per square inch.}$$

Loads and deflections corresponding to these stresses may be obtained from the charts of *Figs.* 5 and 6.

If, for example, the value of s'_e were 70,000 and the yield stress 120,000 pounds per square inch, we may proceed by interpolation to find the value of C_w as follows: In our case $s_y/s'_e=120{,}000/70{,}000=1.71$. For $c=3$, $s_{min}/s_{max}=.5$, $s_y/s'_e=1.5$, from *Fig.* 9 we find $C_w=1.42$. Likewise for $s_y/s'_e=2$ from *Fig.* 10, with $c=3$ and $s_{min}/s_{max}=.5$ we find $C_w=1.53$. Interpolating between these values for $s_y/s'_e=1.71$, there is obtained: $C_w=1.42+(1.71-1.5)/(2.0-1.5)\ .11=1.49$. Then if $N=1.5$

$$s_{max}=C_w(s'_e/N)=1.49\times 70{,}000/1.5=69{,}500 \text{ pounds per square inch.}$$

Evaluation of Working Stress for Cases where the "Sensitivity Index" q is Less than Unity—The previous discussion and the charts of *Figs.* 9, 10 and 11 are based on the assumption of a "sensitivity index" $q=1$. Where test data are lacking, this assumption is on the safe side. In order to evaluate the working stress factor C_w in equation (15) for cases where the material is not completely sensitive to stress concentration (i.e. for the smaller wire sizes and for certain materials), it is necessary to multiply equation (12) by K_f/K_c where K_f and K_c are defined as before. By utilizing equations (9), (11) and (12) and proceeding as before, it is possible to obtain an expression for C_w in terms of q, K_c, s_{min}/s_{max} and s_y/s'_e. Such an expression may be used to prepare charts similar to those of *Figs.* 9 and 11 when values of q determined from tests are known.

Other Limitations of the Charts for Finding C_w—It should be mentioned that in deriving the charts of *Figs.* 9, 10 and 11, it is assumed that the tensile and endurance properties of the material do not change between springs of small and large index. Although this appears to be a reasonable assumption, there are cases where it may not be correct. For example, in cold-wound springs made from a given size of wire, the springs coiled into the smaller diameters will be subjected to the greatest amount of cold working. In this case some difference in properties may be expected. Likewise, when springs are quenched after coiling, the effect of the heat treatment may be different for springs of different indices.

A further effect is due to the residual stress in-

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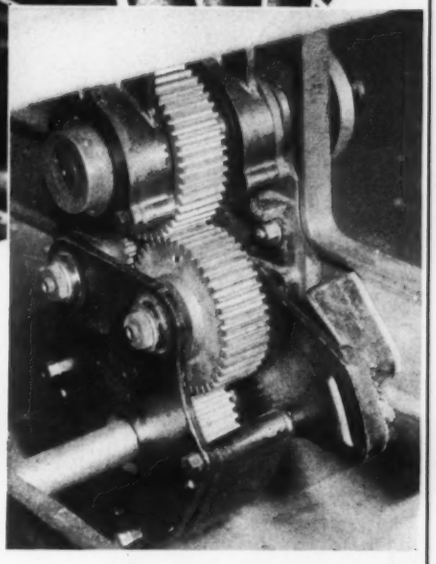

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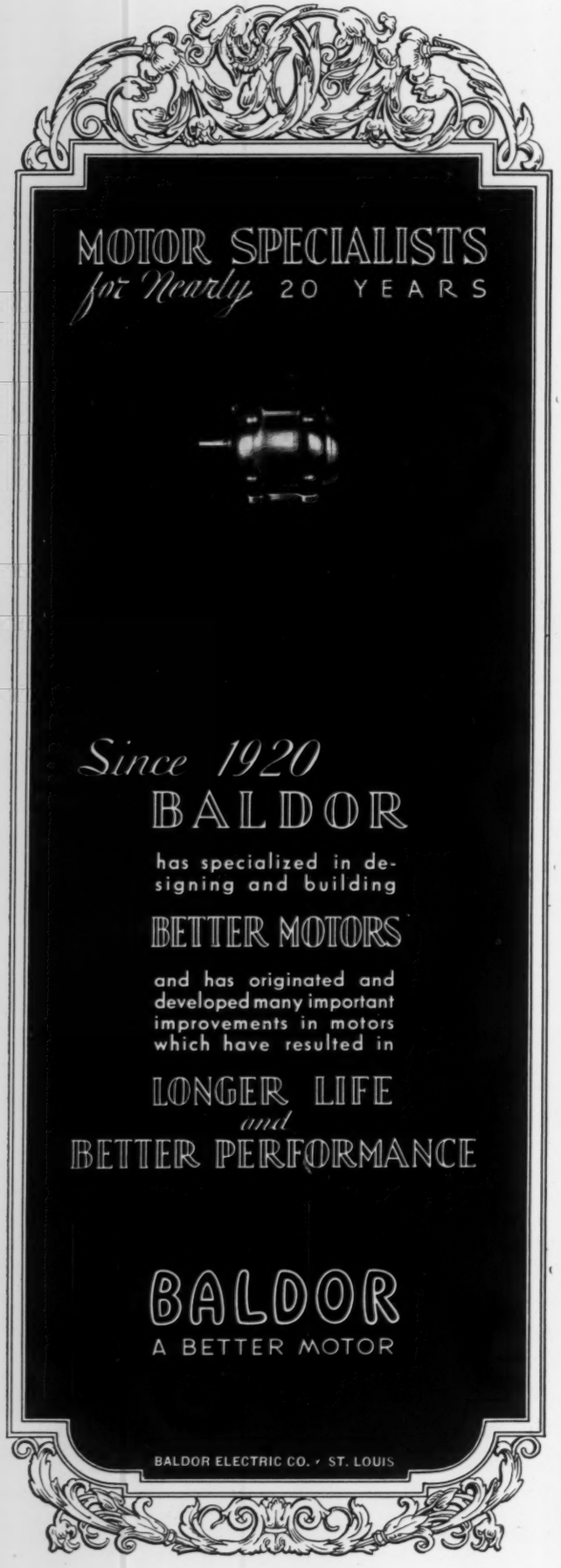


duced by overstressing or surging compression springs (which was discussed in Part I of this series). The sharper the curvature of the spring, i.e. the smaller the index, the easier it will be to produce localized residual stresses. Since these stresses tend to reduce the peak stresses due to applied loads, they may increase the fatigue strength of the springs having the smaller index to a relatively greater extent. It is also realized these effects would be more or less equivalent to changes in the "sensitivity index" q and may be taken into account when further test data are available.

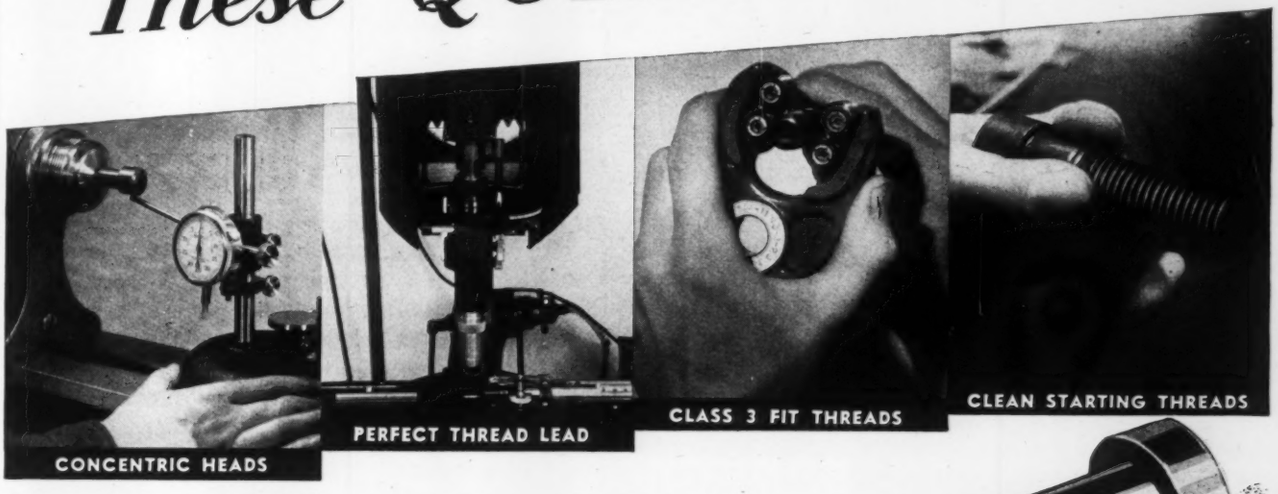
COMPARISON WITH ZIMMERLI'S TEST RESULTS ON HELICAL SPRINGS—Recently the results of some carefully made fatigue tests by Zimmerli on springs of .148-inch diameter pre-tempered Swedish valve-spring wire and having indices varying from $c=3.5$ to $c=12$ have been published [13]. It will be of interest to compare these test results with those obtained by the application of the charts of *Figs.* 9, 10 and 11. The range of stress in these tests varied from s_{min} to s_{max}, as indicated by Table I, Page 41, which gives the limiting values. If we take the results on the springs of largest index ($c=11.9$) as a basis, we have $s_{min}/s_{max}=.21$ and from *Fig.* 9, $C_w=1.10$, for $c=11.9$. Since $s_{max}=91{,}000$ in this case we have from equation (15) for $N=1$, $s'_c=s_{max}/c_w=91{,}000/1.10=82{,}700$ pounds per square inch. For this kind of wire s_y may be estimated as around 120,000 pounds per square inch or $s_y/s'_c=1.5$ approximately which corresponds to the chart of *Fig.* 9. The calculated limiting values of s_{min} and s_{max} were determined by taking the test value of s_{miy} as fixed and calculating s_{max} from the chart using equation (15) and the value of C_w corresponding to s_{min}/s_{max}. On Table I the values of the stress range ($s_{max}-s_{min}$) are given both as found by test and as calculated.

A comparison of the calculated and test values of limiting stress range as shown in the last two columns of Table I indicates that these values differ by only a few per cent. These test data, though few in number, do offer some indication that the method of determining working stress involving the charts of *Figs.* 9, 10 and 11, and assuming a sensitivity index $q=1$, will give results in fair agreement with those of actual fatigue tests, at least for some materials. For other materials and smaller wires, it may happen that the value of q will be less than unity. In the absence of actual test data, however, as mentioned before, it is safest to use the charts of *Figs.* 9, 10 and 11, which assume full sensitivity to stress concentration ($q=1$).

In the next article (Part III) some actual endurance test results on helical springs will be discussed; in addition, some further considerations involved in the design of round and square wire helical springs including buckling effects and eccentricity of loading will be treated.

13. *Transactions* A.S.M.E., January, 1938.

These QUALITIES...



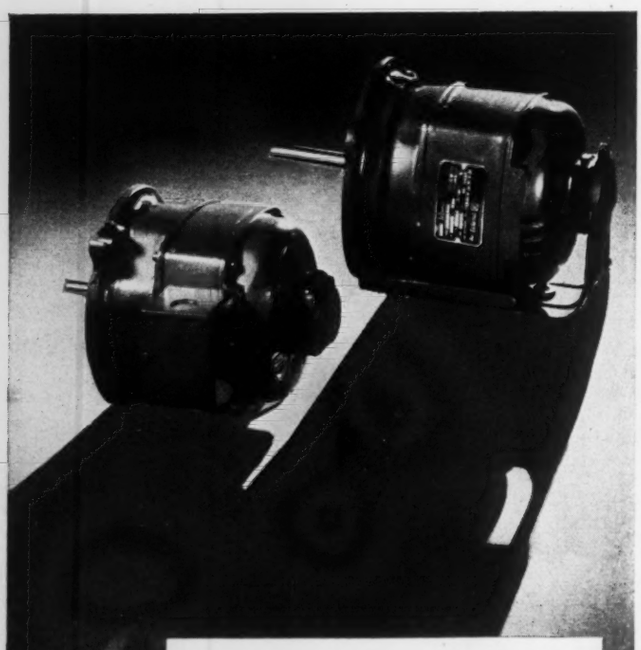
..*have quickly won* WIDE ACCEPTANCE *for Parker-Kalon Socket Screws!*

In the short span of six months Parker-Kalon *Cold-forged* Socket Screws have gained nationwide acceptance. It could not be otherwise. The reason is that they are more than a 'good' product. Two years of research and development... most modern production facilities... a laboratory, without counterpart in the industry, for controlling and maintaining the essential characteristics in Screws of this type... have been combined to produce a product of *unusual* quality.

If you demand precision... uniform strength... appearance ... in the Socket Screws you use—send for free samples. See for yourself how highly these important factors have been developed in Parker-Kalon *Cold-forged* Socket Screws.

PARKER-KALON CORPORATION
212 Varick Street New York, N. Y.

PARKER-KALON
Cold-forged
SOCKET SCREWS



SPECIALIZED MOTORS FOR ALL PRODUCTS

Rare indeed is the appliance which cannot be profitably driven by a Leland motor of the correct design. To oil burners, stokers, air conditioners, water pumps, and scores of other appliances, Leland has added eye and performance appeal.

Most important, Leland will do the same for *your* product.

Get a Leland motor of the correct type and rating. Test it and see for yourself the advantage of specialized design. The Leland Electric Company, Dayton, Ohio.

More Than 200 Fully Equipped Service Stations

LELAND MOTORS

TOPICS

The term "air conditioning" probably had its first official use in a paper given by Willis Carrier at an ASME meeting in 1911, according to L. W. Child, speaking at the recent meeting of the SAE. Mr. Carrier defined air conditioning "as the artificial regulation of atmospheric moisture". Today, Mr. Child points out, the term covers practically everything connected with air. Some believe it means ventilation, others cooling, while still others apply it to any heating or cooling system in a building, vehicle or boat. In an effort to arrive at a safe definition, The Heating and Ventilating Engineers say, "air conditioning is the science of controlling the temperature, humidity, motion and cleanliness of the air within an enclosure". Now if somebody will just get a suitable definition for *streamlining* we may be able to talk and write so others will understand us.

* * *

Recent experiments with powdered lead in greases indicate that this metal may soon assume a position of importance in the lubrication field. In an effort to develop more efficient greases, leaded grease and ordinary greases were compared to determine their relative merits in two similar bearings in actual operation in a gold dredge in California. The leaded grease was found more efficient, reducing the bearing wear by more than one-half and eliminating the scoring of both the bearing and shaft. Furthermore, the bearing with leaded grease required only one-third as much lubricant. From these results, it is estimated that the bearing lubricated with leaded grease would last 2½ times as long as the other.

* * *

Though television still remains at an experimental stage, basic principles of the new science are already exerting a growing influence on modern motor car design. Plymouth engineers, who first employed cathode ray apparatus in acoustical studies for soundproofing the 1937 car, now reveal that similar equipment was used to test the Plymouth engine for 1938. Cathode ray tubes, slightly smaller than the latest television type, were instrumental in perfecting the new type of floating-power engine mounting. Other refinements are said to result from special cathode ray studies of torsional vibration in the crankshaft, drive shaft and transmission parts.

BRING OUT
your Product's Hidden Talents

WITH A BUILT-IN

Counting Device

Some products can do more than you think. And when you discover their hidden talents, you find new opportunities for sales.

For instance:—A gasoline pump that computes its sales sells quicker than one that doesn't. An amusement machine that counts its cash outsells a machine that can't. In fact, any product that multiplies, adds, subtracts, measures, remembers, controls, or records—by means of a built-in counting device—is bound to be more in demand.

Manufacturers of vending and business machines, check recorders, pumps, presses, tractors and many other machines and devices have made their products more useful—more salable—by building in Veeder-Root Counting Devices. And the success stories of these and many other diversified products are given in our interesting booklet "Counting Devices."

SEND FOR A COPY OF THIS BOOKLET

See the wide-spread possibilities of using all kinds of counting devices. Find out if your product can do more—and sell more. Write.

VEEDER-ROOT INC.

HARTFORD, CONNECTICUT

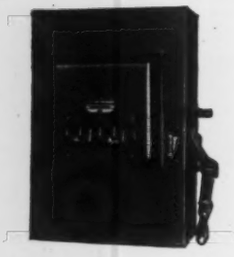
BUILDERS OF COUNTING DEVICES SINCE 1878

Offices in Boston, Chicago, Cincinnati, Cleveland, Detroit, Greenville, S. C., Los Angeles, New York, Philadelphia, Pittsburg, St. Louis, San Francisco, Montreal, Canada, Buenos Aires, Mexico City, London, Paris, Tokio, Shanghai, Melbourne

Materials and Parts

Inspection Window in Breaker Switch

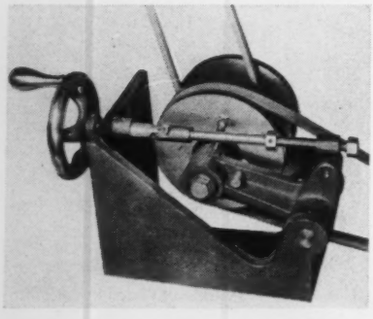
FITTED with a window in the cover to make inspection of blades easy, a new current breaker mill duty safety switch, bulletin 4101, is announced by Cutler-Hammer, Inc., 328 North 12th street, Milwaukee. The window is 3/16-inch shatterproof glass held in place from the inside. A sponge rubber gasket is used to cushion the glass and seal the opening in the cover. Other features of the switch are basically the same as the standard mill duty line, having pressure type fuse clamps, noncurrent carrying hinge posts, silver plated blades and jaws, and interlocked cover with key release and provisions for padlocking. The window type is available in standard sizes from 30 to 1200 amperes up to 600 volts, fusible and nonfusible.



Sponge rubber is used to cushion inspection window glass and seal opening in cover

Simplified Variable Speed Drive

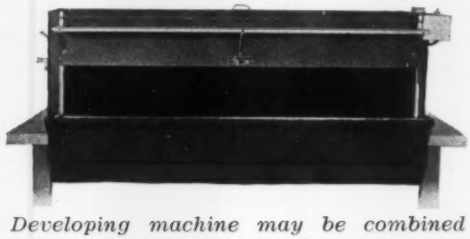
SIMPLIFIED variable speed unit, giving a speed variation of 6 to 1 has been announced by Speedmaster Division, Continental Machine Specialties, Inc., 1301 Washington avenue south, Minneapolis. The unit is completely self-contained and may, therefore, be installed between the driving motor and the driven machine. Handwheel is provided for changing speeds and a supporting angle frame provides convenient mounting. V-belts are employed which run in Bakelite pulleys. To remove the belts for replacement it is only necessary to lift them over the end of the pulley as it is mounted on a stub shaft. Unit is available with pulleys of 6½, 4½ and 3½ inches outside diameter.



Vee-belt variable speed unit is self-contained

Developer Speed Increased

SPEEDS up to 16 feet per minute are possible with a new developing machine, Type 3500, brought out by Ozalid Corp., 354 Fourth avenue, New York. The new machine not only enhances the advantage of the Ozalid positive printing, dry developing process, but effects further economies by permitting the use at high production speeds of sheets cut to standard sizes of the originals, thereby eliminating trimming waste. Built in two sizes for prints up to and including 42 and 54-inch widths, this semiautomatic unit is so designed that it can be combined with the more popular horizontal printers to form a compact unit which will handle either cut sheets or continuous yardage.

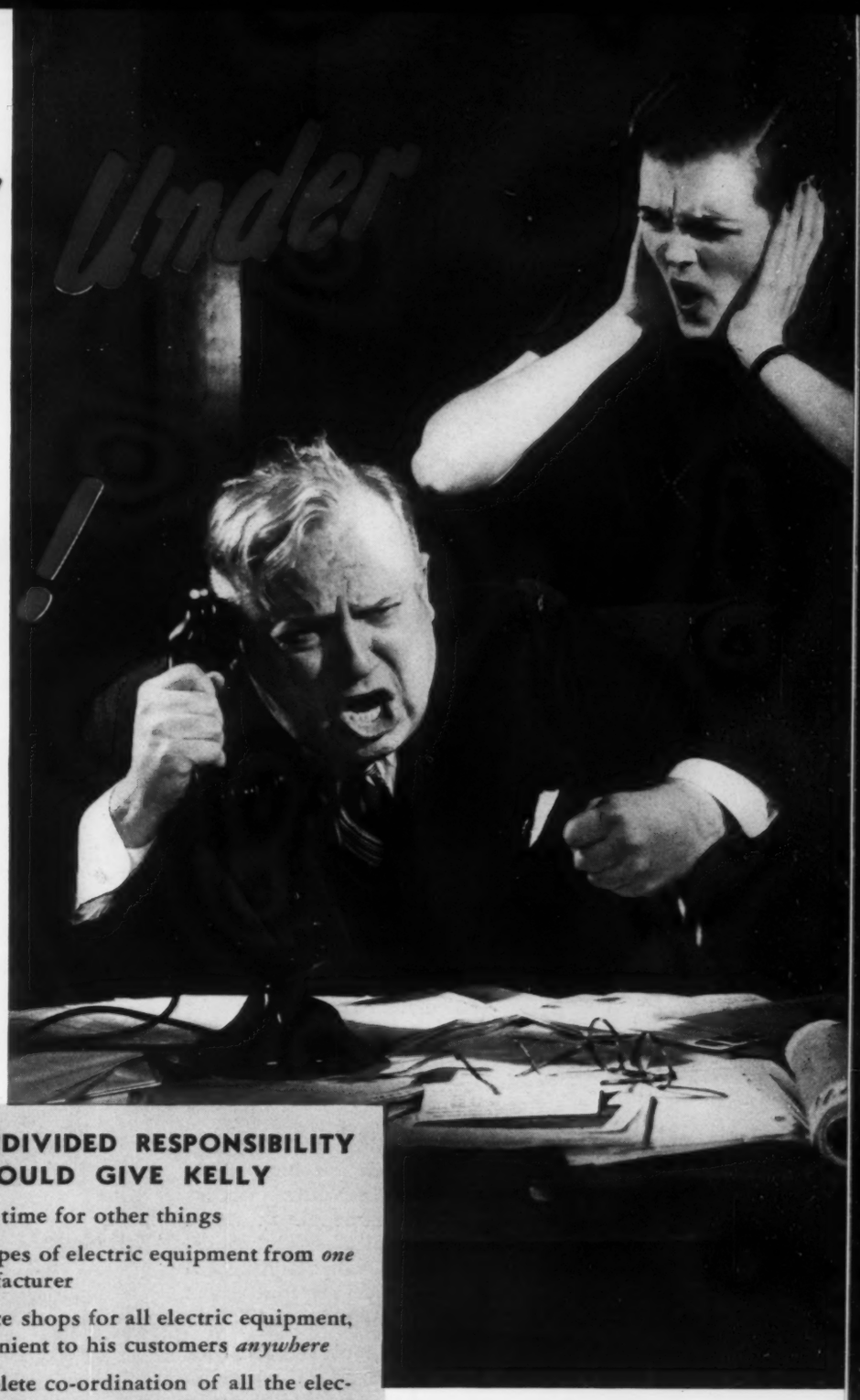


Developing machine may be combined with horizontal printers to form compact unit

Harder Monel Metal Developed

A NEW metal, known as No. 35 Monel, harder in temper and therefore having a higher resistance to wear and abrasion has been placed on the market by The Huntington Works of the International

Snowed but Boiling!



POOR KELLY! Snowed under by a maze of electrical details. He's been trying to piece together many makes of electric equipment for his machines.

How much time he would save by having one manufacturer, such as General Electric, furnish all the electric equipment! No matter what types he might need—motors, control, transformers, cable, or instruments, General Electric could supply and co-ordinate them.

G-E UNDIVIDED RESPONSIBILITY COULD GIVE KELLY

1. **More time for other things**
2. **All types of electric equipment from *one* manufacturer**
3. **Service shops for all electric equipment, convenient to his customers *anywhere***
4. **Complete co-ordination of all the electric equipment for his machines**

Then, when his machines were in the hands of his customers, Kelly could count on General Electric to stand back of the electrical end of them. No matter where they were located, he could be sure that G-E service would be close at hand, available the moment it was needed.

Be sure that you are making the most of these time-saving advantages that Kelly might be enjoying. For you, too, can rely on our engineers to co-ordinate the electric equipment of your machines and assume ***undivided responsibility*** for its meeting your specifications. General Electric, Schenectady, N. Y.

GENERAL ELECTRIC

011-328

FLAMENOL WIRE

REG. U.S. PATENT OFFICE

COMES IN 9 COLORS

Easy to Identify Circuits

RED
WHITE
Lt BLUE
Dk BLUE
GREEN
YELLOW
BROWN
PURPLE
BLACK

WHAT other wire can you get in so many different clear bright colors! Even additional means can be furnished to identify circuits. The covering, Flamenol, can be ridged.

And this is but one of many features peculiar to Flamenol. It won't burn; it resists oil, acids, and alkalis; it has high dielectric and mechanical strength and thus serves both as insulation and finish.

For these reasons, it has proved ideal for wiring machine tools and other high-grade equipment where its properties are the only ones that fully meet conditions. Bulletin GEA-2733 gives details. For a copy address nearest G-E sales office or General Electric, Dept. 6—201, Schenectady, New York.

INSULATED WIRE ALWAYS THE RIGHT TYPE FOR EACH JOB

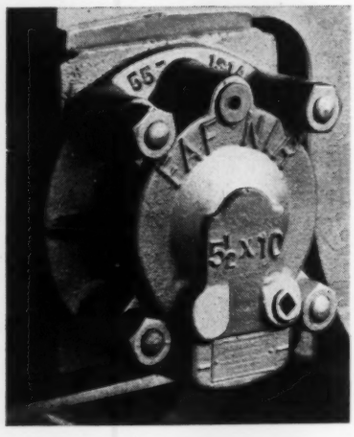
GENERAL ELECTRIC

520-149

Nickel Co., 67 Wall street, New York. This sheet contains the same composition of two-thirds nickel and one-third copper as used in other grades, but possesses several new qualities. Its satin finish is made possible by the installation of new production equipment designed especially for handling Monel. The finish is always uniform. Monel No. 35 is ideal for textile equipment, food machinery, ice cream cabinets and industrial equipment of all kinds where appearance and a fine finish are required.

Ball, Roller Bearings in Journal

COMBINATION ball and roller journal boxes have been developed by Fafnir Bearings, Inc., New Britain, Conn. for railroad equipment. These journal boxes permit free lateral axle movement and are easy to assemble and disassemble for wheel changes. The radial load is carried on hardened solid rolls. Lubrication is positive at all speeds. Insulation with a heavy rubber pad improves ride and deadens noise. Simplified construction and design permits easy installation of the boxes on trucks and axles of present equipment, and their use reduces starting loads as much as 90 per cent, according to the company.



Journal boxes permit free lateral axle movement and may be easily disassembled for wheel changes

Throw-Away Type Filter

THROW-AWAY type air filter for internal combustion engines, ventilating and air conditioning systems, air compressors and warm air furnaces has been developed by C. F. Burgess Laboratories, Inc., 111 W. Monroe street, Chicago. In this filter air is cleaned as it impinges against layers of expanded fiber. These layers are sprayed with a sticky compound that retains dust and pollen. Three sections—a coarse, medium and fine mesh—make up the completed filter. Each layer consists of seven layers of

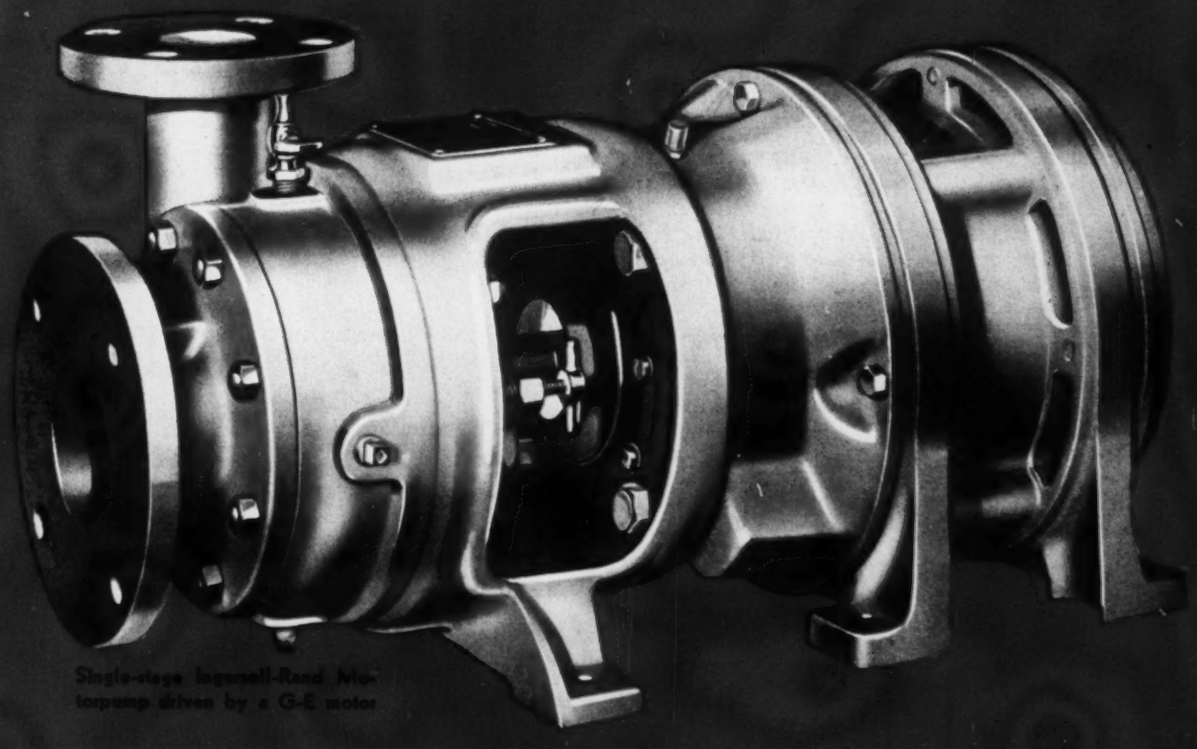
CASE STUDIES OF CO-OPERATION IN BUILDING BETTER MACHINES—No. 4

Ingersoll-Rand Motorpumps *use* G-E MOTORS

WHEN the Cameron Motorpump was designed, G-E motors were selected because General Electric was able to supply the desired type of end-shield mounting for its many different motors—open, splashproof, totally enclosed, fan-cooled, and marine—and because it was able to design and furnish a motor that was exactly suited electrically to the needs of each pump. For these reasons, Ingersoll-Rand was able to produce a sturdy, highly efficient, compact unit.

The Motorpump and the G-E motor were designed to work together—and together they formed a unit of simplified construction, lowered the weight, and increased the saleability.

You, too, will find that G-E motors will prove a profitable addition to your machines. Motors for end-shield mounting, for vertical drive, or for low-speed operation are standard G-E units with which you can build into your products compactness and added performance. And you'll like the service and co-operation General Electric gives you. General Electric, Schenectady, N. Y.



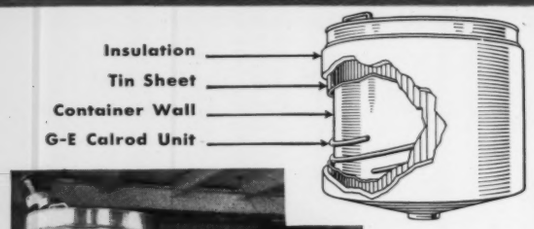
Single-stage Ingersoll-Rand Motorpump driven by a G-E motor

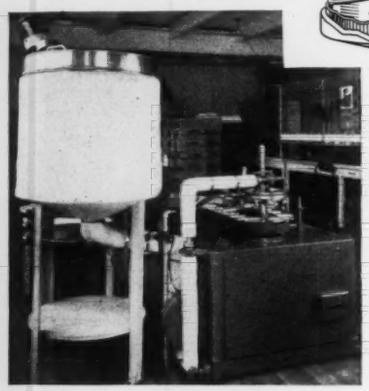
GENERAL ELECTRIC

Filing No. 8058

020-342

ELECTRIC HEAT
MAKES BETTER PRODUCT —AND MORE SALES





IMPROVED packaging made possible by electric heating units built into the packaging machine increased, by leaps and bounds, the sales of the E. W. Rose Company, Cleveland, manufacturer of Zemo ointment.

Zemo is solid at ordinary temperatures; when heated, it flows and neatly fills the containing tins. The ointment must be sterile; when handled with electric heat, it remains clean and pure.

General Electric Calrod heating units, built into the walls of the batch container and applied to the pipes that carry the ointment to the filler heads, maintain the proper temperature. Being built in, they are neat; and being electric, they are easily controlled.

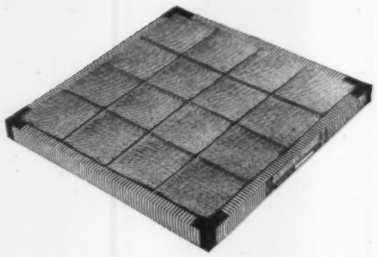
The old method of packaging consisted of a cold fill and had a tendency to smear the containers and lids. The new method makes a clean fill and leaves the package unsoiled. Sales have increased as a result.

G-E heating units may prove an inexpensive and convenient means of applying heat to your machines. For information, write to the nearest G-E sales office or to General Electric Company, Schenectady, New York.

160-49

GENERAL ELECTRIC

the expanded fiber. Because the mesh of the filter baffles becomes progressively finer and as the stickiness increases progressively as the air travels through the filter, there is little danger of surface clogging,

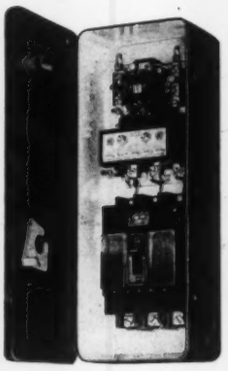


Three layers of coarse, medium and fine fiber, each of seven layers, make up the filter

and dust is deposited uniformly throughout the entire filter. The filter is free of excess stickiness, is clean to handle and has no odor.

Circuit Breakers Built Into Starter

COMBINATION starter utilizing circuit breakers has been developed by Allen-Bradley Co., 1311 South First street, Milwaukee. The conventional type combination starter consists of a hand-operated disconnect switch and an automatic starter. In this new unit, known as Bulletin 713, the standard disconnect switch has been replaced by circuit breakers. These



Sure protection against sustained overloads is afforded by thermostatic relay in starter switch

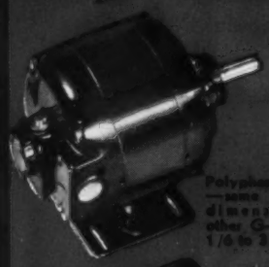
units have a maximum rating of 30 horsepower, 220 volts; 50 horsepower, 440-550 volts. Reliable, accurate protection against sustained overloads is afforded by the resisto-therm relays on the automatic starter. Short circuit protection is provided by the bimetal thermal unit and magnetic trips on the circuit breaker.

Pump Output Easily Controlled

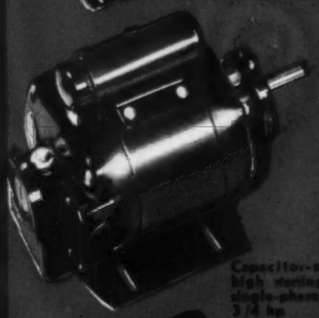
VARIABLE speed, variable capacity rotary pump unit has been developed by Viking Pump Co., Cedar Falls, Iowa. Unit is mounted on the standard, compact, flat belt drive base. By turning the small

Small Motors

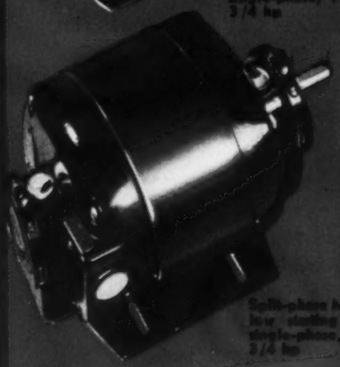
Direct-current Motors—interchangeable with a-c motors, 1/40 to 3/4 hp



Polyphase Motors—same mounting dimensions as other G-E motors, 1/6 to 3/4 hp



Capacitor-motors—high starting torque, single-phase, 1/8 to 3/4 hp

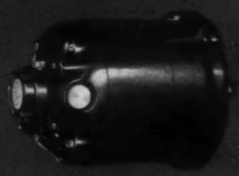


Split-phase Motors—low starting torque, single-phase, 1/40 to 3/4 hp

for

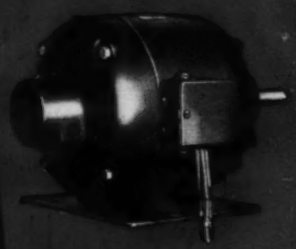
BIG JOBS on . .

COMPRESSORS
DAIRY EQUIPMENT
DRY-CLEANING EQUIPMENT
GREASE GUNS
LIFTS AND HOISTS
MACHINE TOOLS
METALWORKING MACHINES
PUMPS
SHOE MACHINERY
TEXTILE MACHINERY
WOODWORKING MACHINERY
COMMERCIAL-LAUNDRY EQUIPMENT



Flange-mounted Motors—for mounting on the side of a machine

Explosion-proof Motors—tested and listed by Underwriters' Laboratories, Inc.



Totally Enclosed Motors—for operation in dust-laden atmospheres

Gear-motors—compact and efficient, for shaft speeds below 600 rpm

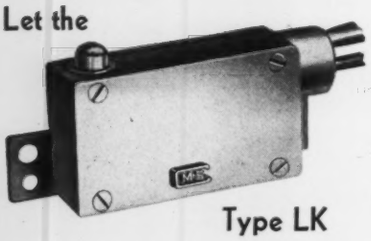
Vertical-mounted Motors—available with ring base, flange mounting, or machined end shields

WHATEVER your requirements, the G-E line is so extensive that it includes a standard line of motors for your machines. And G-E motors will do the job. They are sturdy, and their construction embodies years of experience in building motors to help manufacturers in simplifying the design and assembly of their machines. Each has the correct characteristics for its application. Each is designed for the conditions under which it will operate—totally enclosed for dusty locations, dripproof or waterproof for wet places, explosion-proof for hazardous gas locations, and rubber-mounted for quiet operation. And you have a choice of speeds ranging from 3450-rpm, two-pole motors to 5.7-rpm gear-motors. For additional information, contact the nearest G-E sales office or write to General Electric, Schenectady, N. Y.

GENERAL ELECTRIC

070-238

Let the



Type LK

MICRO SWITCH ACTUATOR

Cut Down Your Production Time and Costs

1 — Movement Differential 0.001″ or less.

2 — Pretravel of actuator plunger to operating point, 0.010″.

3 — Overtravel of actuator plunger beyond operating point 7/32″.

4 — Distance within operating point and C. L. of 3/16″ dowel pin held to ± .003″.

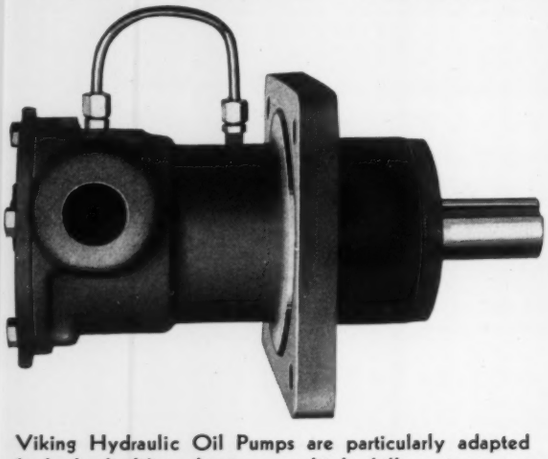
Special double throw single pole Micro Switch and actuating mechanism sealed in a compact metal housing and proof against normal oil and moisture. Precision built to give more than a million operations under severe conditions of high production machine tools. Available in right- or left-hand mounting, 3/8″ conduit coupling optional. Write for specifications and recommendations covering LK Actuator applications.

"SPECIALISTS IN SNAP CONTACTS"

MICRO SWITCH CORPORATION
13 East Spring Street — Freeport, Ill., U. S. A.

Offices in New York and Chicago

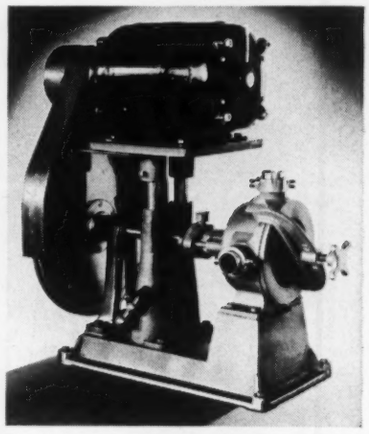
VIKING
HYDRAULIC PUMPS



Viking Hydraulic Oil Pumps are particularly adapted for hydraulic lifts—elevators—multiple drillers—tappers—broaches and other machine tools. Built to endure the strain of the hardest use—extra heavy construction throughout—oversize driving shaft—simple design. Write Viking for full details.

VIKING PUMP CO.
CEDAR FALLS, IOWA.

handwheel located near the base plate, the motor is either raised or lowered, thus changing the pitch of the V-belt motor pulley and regulating the speed. Speed range of the unit, using a standard 1800 RPM motor is from 200 to 500 RPM. Capacity with the pump shown ranges, thereby, from 17 to 42 gallons per minute. The pump and equipment is offered in both standard and sanitary models.



Raising or lowering of motor changes belt pulley diameter giving speed change to pump

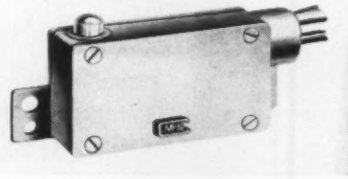
Reducers Have High Ratios

A NEW series of Bond speed reducers, having much higher ratios and greater capacities than formerly available has been announced recently by Charles Bond Co., 617 Arch street, Philadelphia, Pa.

Bond "B" type double reduction speed reducers are capable of handling inputs up to 2 horsepower. Ratios as high as 4000 to 1 are available in both horizontal and vertical types. Bronze worm gears and hardened steel worms with Timken bearings are used.

Foolproof Limit Switch Offered

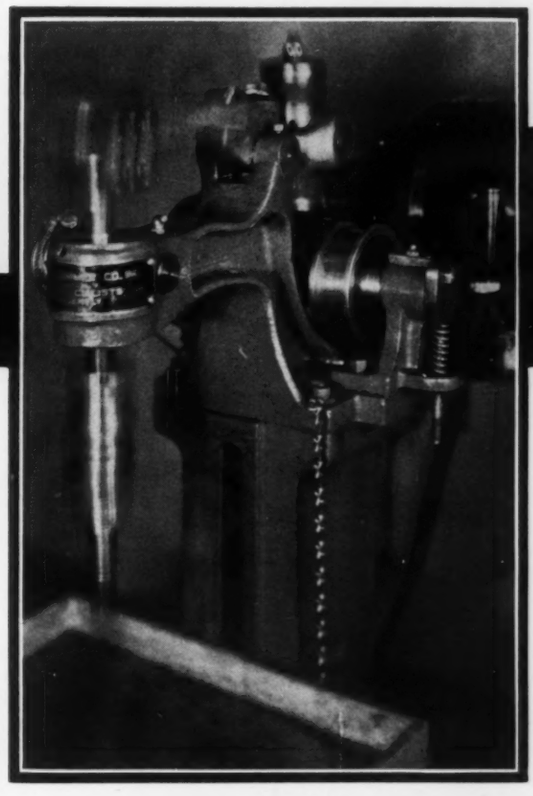
SNAP point of compact interchangeable limit switch, made by Micro Switch Corp., Freeport, Ill., is held in close tolerance relation by dowel holes in the mounting plate. This construction often eliminates the necessity for adjusting actuating parts and makes available the economy of setting to jig. In many applications, replacement of switches can be made without readjustment by using this L-K switch.



Plunger that actuates switch is sealed against oil and water

(*Continued on Page* 90)

*See Below



TESTED AND

Proven

IN THE

GREATEST OF ALL LABORATORIES

. . . . . American Industry

Fig. 232 "UNBRAKO" HOLLOW SET SCREW

Fig. 711 "UNBRAKO" SOCKET HEAD STRIPPER BOLT

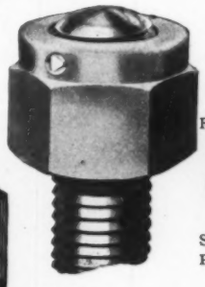


Fig. 1513

UNSHAKO

SELF-LOCKING NUT
Pat'd. and Pats. Pending

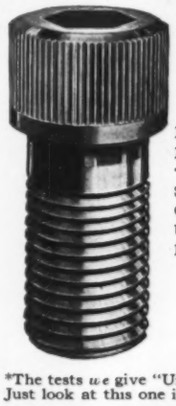


Fig. 1434 KNURLED "UNBRAKO" SOCKET HEAD CAP SCREW U.S. and Foreign Pats. Pending.

Fig. 1564 "UNBRAKO" SELF-LOCKING SET SCREW Pats. Pending

*The tests *we* give "Unbrako" Screws are as tough as we can make them. Just look at this one in action.

UNBRAKO

SOCKET SCREWS

"UNBRAKO" HOLLOW SET SCREWS have been favorites everywhere for nearly 20 years. Finest alloy metals plus expert heat treating give them their acknowledged superiority.

"UNBRAKO" SELF-LOCKING HOLLOW SET SCREWS are a new development. Once turned up tight they'll not loosen unless a wrench is applied. Tiny prongs, raised by knurling the two top threads dig into the threads of the tapped hole to provide this protection.

KNURLED "UNBRAKO" SOCKET HEAD CAP SCREWS are the only ones with the grip that speeds up production. The knurls prevent mechanics' fingers from slipping.

"UNBRAKO" KNURLED SOCKET HEAD STRIPPER BOLTS also have the knurled head that can be turned faster and farther by hand. Socket Head permits more compact design.

"UNSHAKO," *the nut that can't shake loose*, even where vibration is at its worst. It's self-contained, no extra parts to bother with. Can be removed and re-used if desired.

Write for literature, get the complete facts.

STANDARD PRESSED STEEL CO.

BRANCHES BOSTON DETROIT INDIANAPOLIS

JENKINTOWN, PENNA.
BOX 102

BRANCHES CHICAGO ST. LOUIS SAN FRANCISCO

Get acquainted with a good source of

SPRINGS

SEND FOR THE NEW RAYMOND BOOKLET "Spring Principles and Design"

NO OBLIGATION

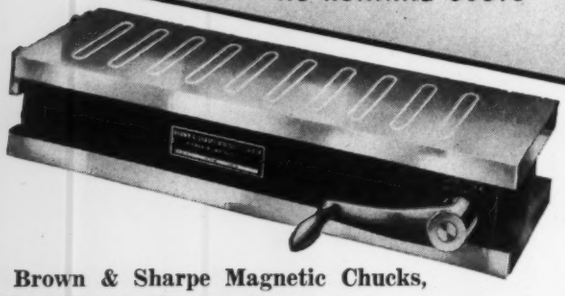
Brief and to the point — written for quick assimilation — contains valuable tables and formulas for various types of springs, small stampings, wire forms. Well illustrated—information in a nutshell for purchasing agents, draftsmen and design engineers. *Send for your free copy on your firm letterhead.*

RAYMOND SPRINGS

RAYMOND MFG. CO.
280 SO. CENTER ST., CORRY, PA.
DIVISION OF ASSOCIATED SPRING CORPORATION

A MAGNETIC CHUCK THAT'S DIFFERENT!

NO WIRES . . .
NO HEATING . . .
NO RUNNING COSTS



Brown & Sharpe Magnetic Chucks, Permanent Magnet Type—

have the advantages of electromagnetic chucks, but do not require any electric current—electrical connections, wires, switches and auxiliary generators are all eliminated. Ask for circular.

Brown & Sharpe Mfg. Co., Providence, R. I. B·S

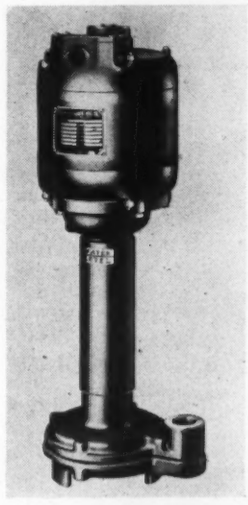
BROWN & SHARPE

(*Continued from Page* 86)

Switch element is the standard Micro switch, rated at ½ horsepower up to 460 volts alternating current. It is sealed in a rugged steel case and actuated by a plunger also sealed against oil and water. Plunger has total travel of ¼ inch, but the switch is actuated by a movement of only .001 inch in the forepart of this travel. Small size of unit, 2¾ x 1-9/16 x 15/16 adapts it to unusual applications in automatic machine tool work or wherever precise limits of motion must be maintained.

Motor Pump Announced

PARTICULARLY suited to the supplying of coolant for machine tools, because of its design for use where dirt or abrasives may be present in the liquid, a centrifugal motor pump, No. 206, has been added to the line of pumps made by Brown & Sharpe Mfg. Co., Providence, R. I. The pump is



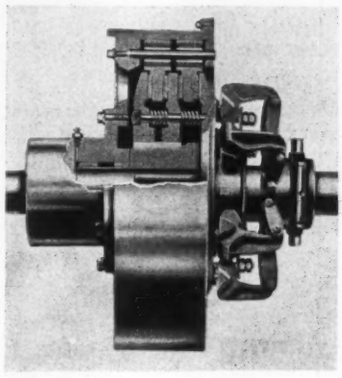
Pump is fitted with fully enclosed motor, grease sealed bearings and stainless steel pump shaft integral with motor

fitted with a fully-enclosed motor and grease sealed bearings. Stainless steel shaft is integral with the motor, giving simplicity and strength, and the aluminum bronze impeller is the open or nonclogging type. Provision is made in the design to prevent rise of liquid in the shaft housing above the level of the supply, to protect the motor.

Rubber Bushings Cushion Clutch

DESIGNED especially for use on oil, gas and diesel engines or on drives where heavy impact is encountered, a combination friction clutch and flexible coupling has been announced by T. B. Wood's Sons Co., Chambersburg, Pa. Disks are driven by steel pins cushioned by rubber bushings instead of by keys. These bushings have special, self-lubricating bronze

bushings on the inside of the rubber, allowing the disks to slide freely on the steel pins. The rubber is cemented firmly into the friction disks. These unique



Bronze bushings are placed on inside of rubber bushings to allow clutch disks to slide freely on the steel pins

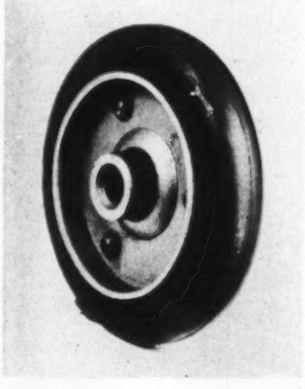
bushings eliminate knocks, absorb shocks and add considerably to the life of the clutch.

High Dielectric Strength in Plastic

A THERMOPLASTIC with exceptionally low electrical leakage, made of Bakelite polystyrene molding material (XMS-10023), has been announced by Bakelite Corp., New York. Bakelite polystyrene possesses a loss factor of less than .00053, a power factor of less than .0002, and a dielectric constant of 2.60 at 60 cycles, 1,000 cycles and 1,000,000 cycles.

Rubber-Tired Wheels for Conveyors

SMALL rubber-tired wheels have been developed by Mathews Conveyer Co., Ellwood City, Pa., for mounting on light frames that serve as conveyors



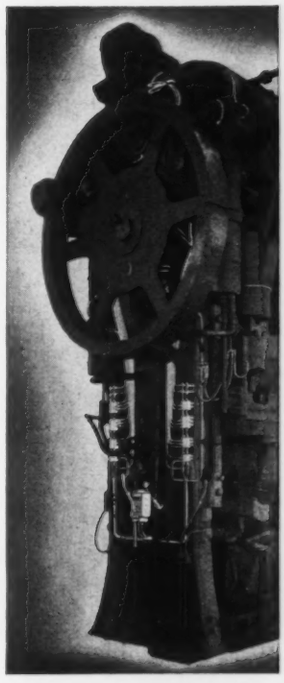
Small wheels have rubber tires to protect articles handled by conveyors

for shingles, steel sheets, glass or any fragile object which must be protected from jarring or scratching. The wheels, although developed for conveying, are

Special Delivery

TO EVERY BEARING

Design Engineers:



Farval provides immediate and positive delivery to every bearing in less than one minute, from one safe, conveniently-located central pumping unit. Every bearing receives exactly the amount of lubricant it requires, regardless of the number or where they may be located.

"Special delivery" via the Farval System means increased production, reduced labor of oiling, savings in lubricant, reduced repair and maintenance expense, and prolonged life of equipment.

Increased output and lower costs on the equipment you design will result from the correct installation of a modern Centralized System of Lubrication.

The years of experience gained by Farval in the design and application of lubricating systems to all types of equipment are available to Machinery Designers through our staff of trained Lubricating Engineers.

There is one in your locality and he will be glad to call. The Farval Corporation, 3265 East 80th St., Cleveland, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Cleveland, Manufacturers of Automotive and Industrial Worm Gearing.

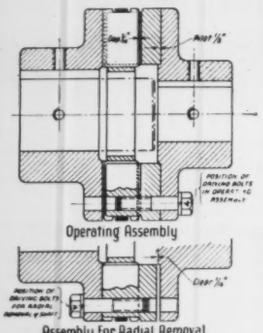
FARVAL

CENTRALIZED SYSTEM OF LUBRICATION

Special Delivery to Every Bearing

L-R *everlasting* FLEXIBLE COUPLING
NON-LUBRICATED

L-R FLEXIBLE COUPLING TYPE "WQ"



Operating Assembly

Assembly for Radial Removal of Connected Shafts

A New Development of the L-R Principle

EASILY ESTABLISHED CLEARANCE SIMPLIFIES ENGINE ROOM TASKS

Step One

Helper with wrench loosens a few cap screws.

Step Two

Pulling over movable jaw ring creates $\frac{1}{16}$" clearance. As shafts are now free it is possible

WITHOUT TEARING DOWN COUPLING

(a) To ROTATE shaft of either unit INDEPENDENTLY

(b) SET engine without disturbing companion unit;

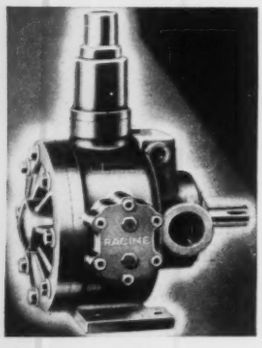
(c) REMOVE either unit without disturbing other unit

L-R Flexible Couplings require no lubrication—they are practically everlasting. Type WQ illustrated is one of a number of types of L-R Couplings with bores from $\frac{3}{16}$" to 14"—a flexible coupling for every need.

Write for Engineering Data

LOVEJOY FLEXIBLE COUPLING CO
5018 WEST LAKE ST. CHICAGO, ILLINOIS

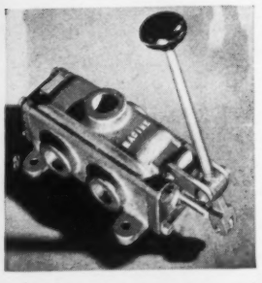
RACINE
Variable Volume Hydraulic Pumps



Extremely quiet, smooth performance. A thoroughly proven, efficient pump for pressures up to 1000 lbs. per sq. inch. Capacities 2000—4000—6000 cubic inches per minute.

The Variable Volume feature saves horse-power. Delivers amount of oil actually required. Volume is controlled automatically or manually.

Write for new catalog P-10



Racine Hydraulic Valves

A complete line—manual—pilot or electrically operated. Balanced pistons—Accurately fitted.
For oil-hydraulic installations.

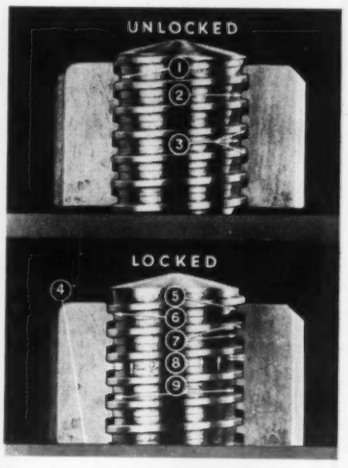
Write for new catalog V-10

RACINE TOOL & MACHINE CO.
1773 State St. Racine, Wis.

suitable for other uses where quiet, smooth travel is essential. They are of pressed steel construction, having hardened steel inner and outer ball races. The smaller model is 2⅞ inches in diameter with a rated capacity of 20 pounds. The larger wheel is 3½ inches in diameter and will carry 50 pounds. Identifying numbers of the wheels are 70-RT and 84-RT, the latter being of the heavier construction.

Self-Locking Thread Improved

REFINEMENT of the Dardelet self-locking thread has been announced by Dardelet Threadlock Corp., 55 Liberty street, New York. The new thread, like the old, requires no extraneous part to produce a positive lock of the two threaded members. It possesses advantages of being a free-spinning nut, giving rapid development of bolt tension, a gradually increasing lock action and an improved power or grip of its lock. Known as the Dardelet relieved profile screw, the lower half of the bolt thread locking angle has clearance between the bolt and nut threads when assembled in the unlocked position, which allows broader tolerances for dimensions at the tapered portion of the threads. This also enables the nut to be spun rapidly when setting it up.



Threads on nut have clearance for free spinning in the unlocked position

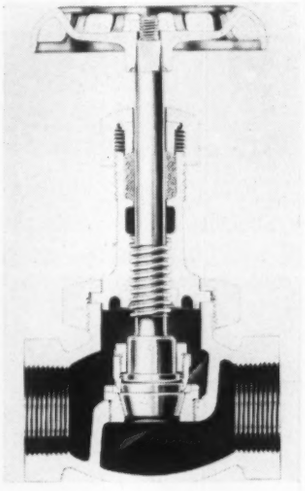
Tray for Drawing Instruments

FOR attachment to the drafting table, a "handy tray" to hold drawing instruments, scales, pencils, etc. has been brought out by W. D. Fabling Co., 722 North Broadway, Los Angeles, Calif. By use of this attachment the drawing board is kept free of instruments. A revolving tray for ink bottles, ash tray and instrument tray make up the complete assembly. They are mounted on a shaft which is attached by an ad-

justable locking type bracket, allowing the trays to be kept in a level position regardless of the angle of the drawing board.

Stainless Steel Used in Valve

STAINLESS steel having a hardness of 500 Brinell is used for the plug and seat ring of a valve brought out by Jenkins Bros., 80 White street, New York. The valve is specially recommended for severe service

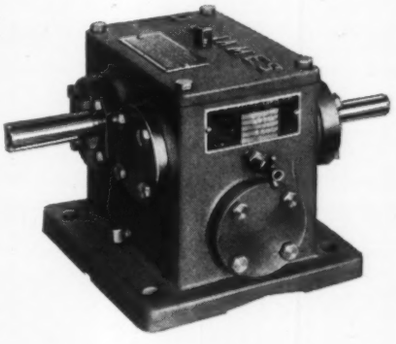


Wire drawing and cutting of valve seat is practically eliminated by use of hardened stainless steel

such as continuous throttling in steam lines. Use of stainless steel for vulnerable parts practically nullifies wear and eliminates to a great extent the danger of wire drawing and cutting. This steel is harder than the majority of ordinary materials that become lodged in pipe lines.

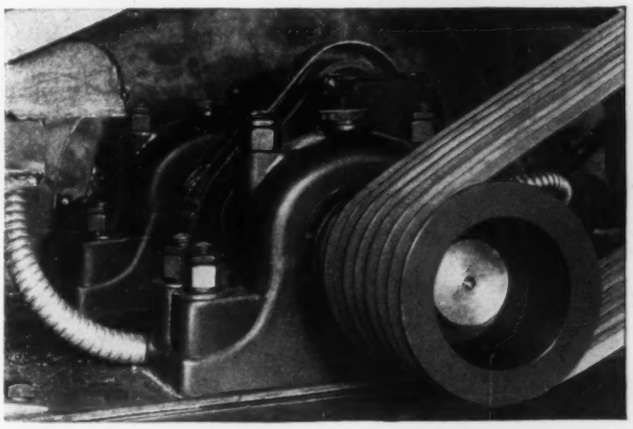
Speed Reducer Line Announced

DOUBLE worm gear reducers with large range of speed ratios from 30 to 3600 to 1 have been placed on the market by D. O. James Manufacturing Co., 1114 West Monroe street, Chicago. Torque ca-



Tapered roller bearings are included in this double worm gear

They're Rugged!



Dodge-Timken Bearings
PROTECT YOUR REPUTATION

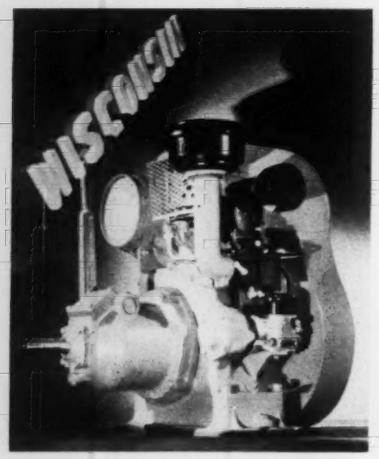
That steady, severe service that bearings are bound to encounter "weeds" out the weaklings and brings out the leaders. That is why Dodge-Timken Bearings are widely preferred by machine designers as rugged aids to the uninterrupted performance of the entire unit. Designed and built to insure satisfactory performance under every service condition, these famous bearings protect your good name and reputation. Specify *Dodge*. There's more than half a century of success behind that name.

Let us send you a copy of our bulletin A-206 which describes Dodge Rolling Bearings.

DODGE MANUFACTURING CORPORATION
MISHAWAKA, INDIANA U. S. A.

THE Right DRIVE FOR EVERY JOB

DODGE
MISHAWAKA
THERE IS ADDED VALUE IN THE NAME DODGE



A reproduction of Model AG—6H.P. Engine with clutch and power take-off.

8 sizes—1 to 16H.P.

STURDY, POWERFUL UNITS DESIGNED FOR HARD SERVICE

HEAVY DUTY AIR COOLED ENGINES by WISCONSIN MOTOR CORPORATION

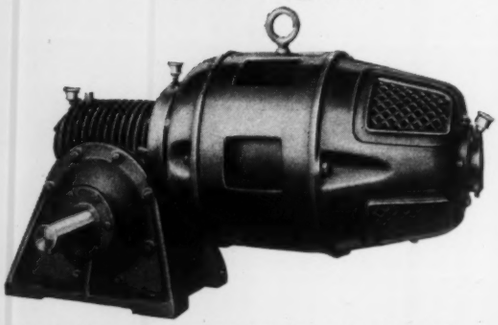
Still they weigh less — they take up less space and they cost less. Ask for complete catalog.

WISCONSIN MOTOR CORP., MILWAUKEE, WIS.

Janette

MOTORIZED SPEED REDUCERS

A PRECISION BUILT LINE OF **16 DIFFERENT TYPES** OF MOTORIZED SPEED REDUCERS, 1/20th to 7—½ H. P.



Illustrating Type RW4—Single reduction—Worm gear—Reducer driven by a Janette Slip Ring Motor

The diversity of the Janette custom built line of motorized speed reducers enables us to supply a machine for almost any purpose. Let our engineers help in selecting the right type for your application.

Rotary Converters—Generators—Motors—Motor-Generators

Janette Manufacturing Company

556-558 West Monroe Street Chicago, Ill. U.S.A.

BOSTON - NEW YORK - PHILADELPHIA - CLEVELAND - MILWAUKEE - LOS ANGELES DETROIT - SEATTLE

pacities of the three new sizes at the slow speed shaft are from 40 to 400 inch-pounds. This type of speed reducer consists of two bronze worm gears and steel worms mounted on tapered roller bearings, giving a light drive with high ratios.

Meetings and Expositions

Feb. 8—

Foundry Equipment Manufacturers' association. Annual meeting to be held at Cleveland hotel, Cleveland. A. J. Tuscany, 632 Penton building, Cleveland, is executive secretary.

March 9—

American Society of Tool Engineers. Machine tool and equipment show to be held at Convention Hall, Detroit. Additional information may be obtained from A. F. Denham at the society's headquarters, 5928 Second boulevard, Detroit.

Feb. 9-10—

Steel Founders' Society of America. Annual meeting at Hotel Cleveland, Cleveland. R. L. Collier, 920 Midland building, Cleveland, is secretary.

March 10-11—

Society of Automotive Engineers. National aeronautic meeting at Mayflower hotel, Washington. John A. C. Warner, 29 West Thirty-ninth street, New York, is secretary and general manager.

March 14-17—

American Society of Bakery Engineers. Annual meeting to be held at Edgewater Beach hotel, Chicago. Victor E. Marx, 1541 Birchwood avenue, Chicago, is secretary.

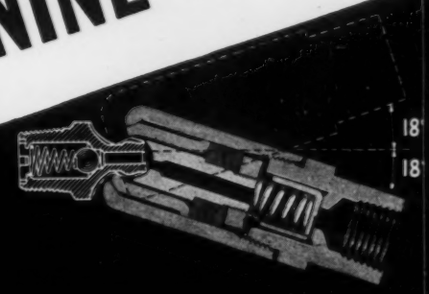
March 15-17—

National Scale Men's association. Annual meeting and exposition to be held at Sherman hotel, Chicago. R. O. Rask, 916 West Grove street, Bloomington, Ill., is secretary.

Exposition of Stainless Steel opened for a period of several months in the New York Museum of Science and Industry, RCA building, Rockefeller Center, New York. This exposition is sponsored jointly by Electro Metallurgical Co. and the museum. Open every day and evening.

COMPLETELY ALEMITE EQUIPPED

NO BEARING FAILURES IN NINE YEARS!



Even when applied from an 18° angle, the Alemite Hydraulic Gun grips the Alemite Hydraulic Fitting to make an absolutely leakproof seal. No lubricant can escape to contaminate products or machines!

Machines Now Lubricated in One-Eighth Former Time!

THIS big Buffalo plant of Allied Mills, Inc., was built nine years ago. All machines are equipped with Alemite Fittings. Alemite Guns and Alemite Lubricants are used throughout the plant. *In nine years they haven't had a single bearing failure!*

Furthermore, says Plant Superintendent Martin, an average of one hour's time every day is sufficient to take care of all lubrication — whereas in other plants of the same size the same job without Alemite Equipment takes about eight hours a day! *One hour a day against eight hours a day!* No wonder Alemite users cheer *both* Alemite's economy and dependability!

Thousands Standardize on Alemite

Such performance records as that of Allied Mills tell you why so many machinery manufacturers put Alemite Fittings on all their machines as standard equipment. When you say, *"It's Alemite-equipped,"* your customer knows he need have no lubrication worries — that he need not fear bearing failures — and that neither machines nor products will suffer from oil contamination! *That's a powerful array of sales arguments to gain at such small cost!* Alemite Engineers are entirely at your service for lubrication counsel on any new machines you may design. Write to us!

ALEMITE — *A Div. of Stewart-Warner Corporation*
1804 Diversey Parkway, Chicago, Illinois
Stewart-Warner Alemite Corporation of Canada, Ltd.
Belleville, Ontario

ALEMITE
REG. U. S. PAT. OFF.
WORLD'S LARGEST MANUFACTURER OF LUBRICATION PRODUCTS

Enjoy Horace Heidt and his Alemite Brigadiers every Tuesday evening, National Broadcasting Company Coast-to-Coast Network, 9:00 P. M., Eastern Standard Time.